IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF ILLINOIS

DAO HEALTH, Plaintiff, v. SHENZHEN LUTEJIANCHENG TECHNOLOGY CO., LTD. Defendant.	Civil Action No. 1:23-cv-04885 Judge Thomas M. Durkin Magistrate Judge Beth W. Jantz **JURY TRIAL DEMANDED**

DEFENDANT SHENZHEN LUTEJIANCHENG TECHNOLOGY CO., LTD'S
APPENDIX IN SUPPORT OF ITS OPENING CLAIM CONSTRUCTION BRIEF

Pursuant to Local Patent Rule 4.2(b), Defendant Shenzhen Lutejiancheng Technology Co., Ltd. ("Momcozy") hereby submits this Appendix in Support of its Opening Claim Construction Brief ("Momcozy Appendix"), which contains the materials referenced in Momcozy's Opening Claim Construction Brief (filed contemporaneously herewith) that are not included in the parties' Joint Claim Construction Appendix (also filed contemporaneously herewith).

A table identifying and setting forth the Momcozy Appendix pagination ("MA") for these materials is set forth below:

Document	Momcozy Appendix Pages	Original Production Numbering
U.S. Patent No. 4,270,538 ("Murphy")	MA0001-MA0005	R000455-R000459
U.S. Patent No. 7,223,255 ("Myers")	MA0006-MA0060	R153626-R153670
U.S. Patent No. 6,379,327 ("Lundy")	MA0051-MA0060	R001065-R001074
"assembly", Webster's New Collegiate Dictionary, 1981 ed.	MA0061-MA0063	R226828-R226830

Dated: January 8, 2025

/s/ Steven H. Sklar
Steven H. Sklar
Gregory C. Bays
Nicole E. Kopinski
Pei Raymond Chen, Ph.D. (*pro hac vice forthcoming*)
LEYDIG, VOIT & MAYER, LTD.
ssklar@leydig.com
gbays@leydig.com
rchen@leydig.com
Two Prudential Plaza, Suite 4900
180 North Stetson Avenue
Chicago, IL 60601
Telephone: (312) 616-5600
Facsimile: (312) 616-5700

Attorneys for Defendant
Shenzhen Lutejiancheng Technology Co., Ltd.

CERTIFICATE OF SERVICE

I hereby certify that on January 8, 2025, a true and correct copy of the foregoing document and attachments was served on the following counsel of record via the Court's electronic filing system:

Howard B. Rockman ROCKMAN, VIDEBECK & O'CONNOR, LLC 1S376 Summit Avenue, Court C Oakbrook Terrace, IL 60181 Telephone: (630) 627-4552 *rockman@rvoiplaw.com*	Yanling Jiang Yi Bu JIANGIP 33 West Jackson Blvd. Chicago, IL 60604 Telephone: (630) 733-9483 *yanling@jiangip.com* *ybu@jiangip.com*
Meng Xi Shawn Blackburn Samuel Drezdzon SUSMAN GODFREY LLP 1000 Louisiana Street, Suite 5100 Houston, TX 77002 Telephone: (713) 551-9366 *mxi@susumangodfrey.com* *sblackburn@susmangodfrey.com* *sdrezdzon@susmangodfrey.com*	Tanner Laiche SUSMAN GODFREY LLP 401 Union Street, Suite 3000 Seattle, WA 98101 Telephone: (206) 516-3880 *tlaiche@susumangodfrey.com*

Attorneys for Plaintiff,
Dao Health

s/ Steven H. Sklar
Steven H. Sklar
LEYDIG, VOIT & MAYER, LTD.

United States Patent [19]

Murphy

[11] **4,270,538**

[45] **Jun. 2, 1981**

[54] **BREAST SHIELD**

[76] Inventor: **Michael K. Murphy**, 21 Hillcrest Dr., San Rafael, Calif. 94901

[21] Appl. No.: **72,954**

[22] Filed: **Sep. 6, 1979**

Related U.S. Application Data

[63] Continuation of Ser. No. 847,281, Oct. 31, 1977, abandoned.

[51] **Int. Cl.**³ **A61M 1/08**; A41C 3/00

[52] **U.S. Cl.** **128/282**; 128/461

[58] **Field of Search** ..... 128/280, 282, 461, 150; 220/90.4, 1 C, DIG. 27

[56] **References Cited**

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3,840,012	10/1974	Rushton, Jr.	128/280

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63985	3/1949	Netherlands	128/282
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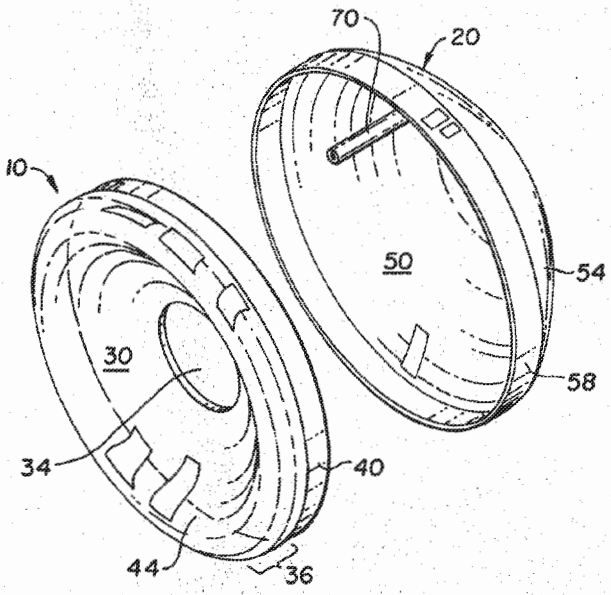
Primary Examiner—Robert W. Michell
Assistant Examiner—C. W. Shedd
Attorney, Agent, or Firm—Townsend and Townsend

[57] **ABSTRACT**

A two-piece breast shield to be worn by a nursing woman is disclosed. A base, contoured to confront the wearer's breast, has an aperture through which the nipple can pass. A dome-shaped cover overlies the base, fitting onto it to define an interior milk-receiving chamber. A small vent hole near the edge of the cover is surrounded by an inwardly extending tube to prevent milk from flowing out through the hole when the woman wearing the breast shield bends over.

2 Claims, 8 Drawing Figures



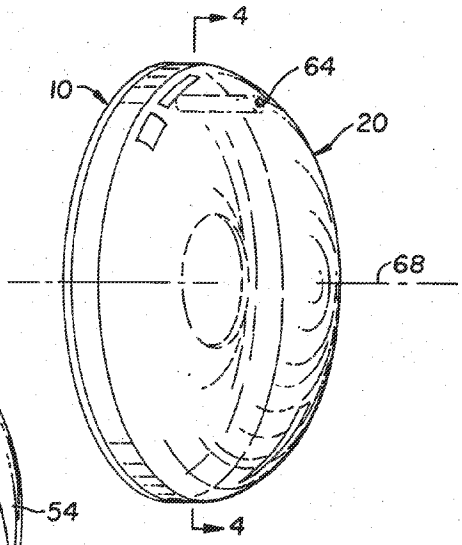


FIG. 1.

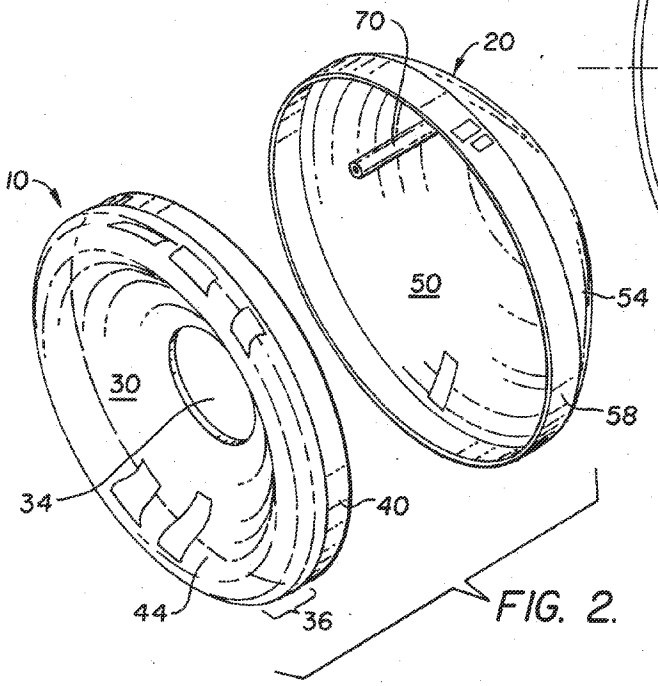


FIG. 2.

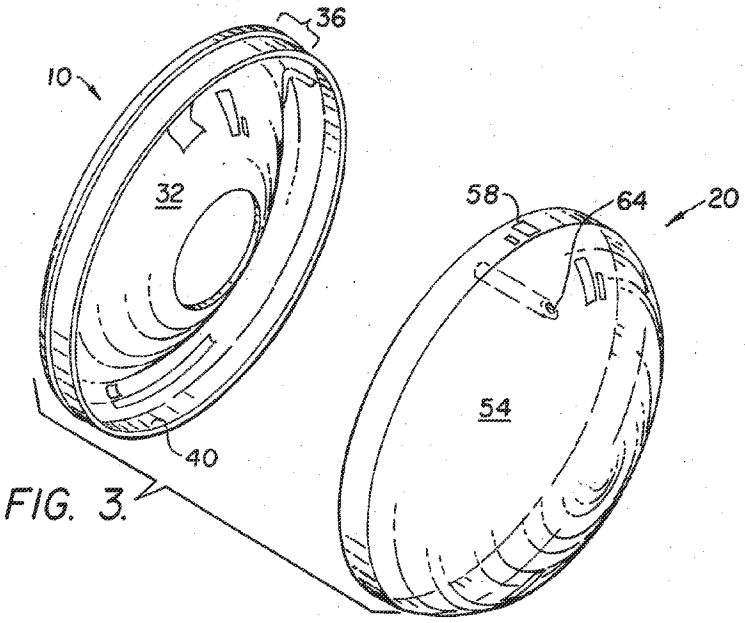


FIG. 3.

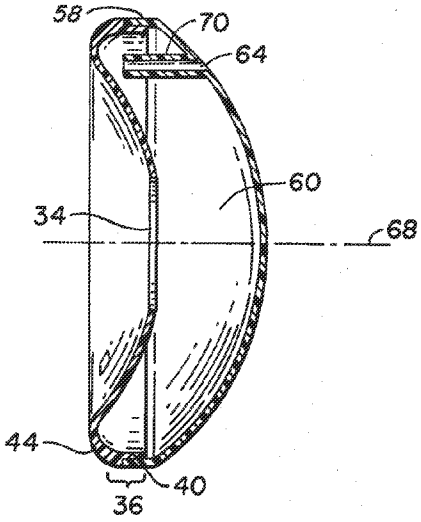


FIG. 4.

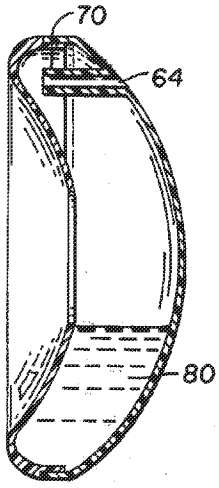


FIG. 5a.

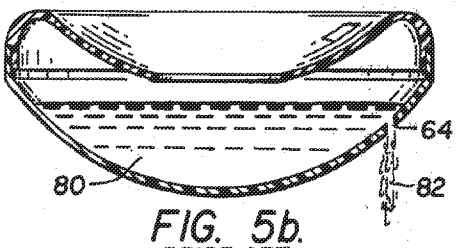


FIG. 5b.
PRIOR ART

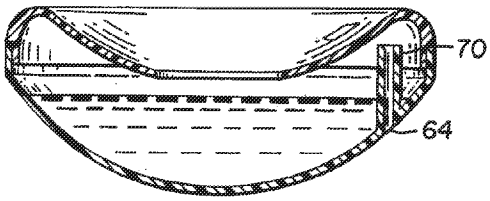


FIG. 5c.

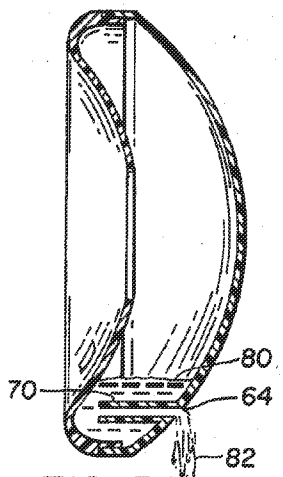


FIG. 5d.

BREAST SHIELD

This is a continuation of application Ser. No. 847,281, filed Oct. 31, 1977, now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to breast shields that also function as milk collectors.

While breast feeding of infants is thought by many to provide numerous advantages, including overall convenience, it is not without its own inconveniences. The two major problems tend to be soreness of the nipple and leakage of milk between feedings. It is with these problems in mind that numerous devices have been developed.

U.S. Pat. No. 3,840,012 to Rushton, Jr., discloses a two-piece hollow breast shield which also functions as a milk collector. The device has a breast-confronting base and an overlying exterior cover. Such a hollow device fitting over the breast presents at least two problems. First, the very shape of the breast shield makes it likely that a vacuum will form within the milk receiving chamber. This would make removal of the device painful, and might even cause damage to the already delicate tissues.

Second, it is awkward to recover for use the milk that has collected within the device. Generally it will be necessary to disassemble the device, taking care that the cover is kept in a level position so that the milk accumulated therein is not spilled until it is poured out. The extra handling during disassembly increases the possibility of contamination and enhances the chance of spilling the collected milk, as for example by dropping the cover.

A solution for these problems, suggested by Rushton, is the provision of a small orifice in the cover near the top of the device for pouring out the collected milk. This small orifice also vents the interior of the breast shield, thereby preventing the formation of a vacuum within it.

However, this proposed solution has its own difficulty. When a woman who is wearing the breast shield in which milk has collected bends over, the milk leaks out of the small hole. The woman's clothing is soiled, and if the leakage extends to the woman's outer garments, it may prove to be a source of embarrassment. Thus, the effort to solve the aforementioned venting and emptying problems has led to a device with the same "leaking" problem that it was a major object of the breast shield to eliminate.

Accordingly, it is an object of this invention to provide a breast shielding, milk collecting device which provides a vented interior and yet does not suffer from the "leakage" problem.

SUMMARY OF THE INVENTION

A two-piece breast shield, preferably fabricated from slightly flexible plastic, also functions as a milk collector. The device fits over a woman's breast and is typically held in place by a brassiere. A round base having a concave breast-confronting surface and a convex chamber defining surface is provided with a central aperture for the nipple to pass through. A peripheral lip surrounds the convex chamber defining surface and extends away from the breast when the device is worn. A dome-shaped cover having a concave chamber defining surface and an outer convex surface fits over the base without contacting the nipple. Thus, the nipple is protected from contact with the brassiere. A peripheral lip surrounds the concave chamber defining surface and has an inner diameter substantially equal to the outer diameter of the lip surrounding the convex chamber defining surface on the base. Thus, when the base and the cover are pressed together, the peripheral lips hold the unit as one piece to provide a milk receiving chamber within. A small orifice is provided near the edge of the cover, and is positioned near the top of the shield when the shield is in place.

Leakage and spillage through the small orifice is prevented by an inwardly extending tube surrounding the orifice and extending into the chamber from the concave chamber defining surface. Thus, when a woman wearing the breast shield in which milk has accumulated bends over, the tube acts as a dam around the orifice and prevents the loss of milk through the orifice. If the wearer of the shield wishes to empty the milk out without disassembling the shield, she can do this by rotating the shield 180 degrees from its normal position. The orifice, surrounded by the tube, is then at the bottom position of the shield. The tube is submersed in the milk which is then able to flow out of the orifice.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view from the front showing the breast shield in its assembled state.

FIG. **2** is a perspective view from the rear, showing the breast shield disassembled.

FIG. **3** is a perspective view from the front showing the breast shield disassembled.

FIG. **4** is a sectional view along the line **4**—**4** of FIG. **1**.

FIG. **5***a* is a sectional view of the milk-filled breast shield in its vertical position.

FIG. **5***b* is a sectional view of a milk-filled breast shield not having the tube of this invention when the breast shield is horizontal.

FIG. **5***c* is a sectional view of the milk-filled breast shield in a horizontal position.

FIG. **5***d* is a sectional view of the milk-filled breast shield in an inverted position for emptying.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. **1** shows base **10** and cover **20** assembled so that the breast shield is ready for wearing. The parts are typically constructed of slightly flexible plastic, preferably translucent. In use, the breast shield is placed over the breast and held in position by a brassiere. With reference to FIGS. **2** and **3**, the detailed construction of base **10** and cover **20** can be seen.

Base **10**, substantially circular, has a concave breast confronting surface **30** and a convex surface **32**. A central circular aperture **34** provides clearance for the nipple to pass through. The edge of base **10** surrounding aperture **34** is rounded so as not to present any sharp edges which could injure the nipple when the breast shield is removed or shifted transversely.

Projecting outwardly from convex surface **32** (i.e., away from the breast) is peripheral lip **36** having a portion **40** remote from surface **32** whose thickness is reduced from the outside. The transition between the breast confronting surface **30** and the peripheral lip **36** is accomplished smoothly by having peripheral portion **44** curved in the opposite direction to that in which surface **30** is curved.

Cover 20, which overlies base 10, has a concave chamber defining surface 50 and an outer convex surface 54. Concave chamber defining surface 50 is surrounded by peripheral lip 58 which extends away from surface 50 (i.e., toward base 10), while providing an overall external diameter the same as that of base 10.

Peripheral lip 58 has a thickness that corresponds to the reduction in thickness of peripheral lip 36. Moreover, the outer diameter of portion 40 of peripheral lip 36 corresponds closely to the inner diameter of peripheral lip 58, so as to allow a snug mating wherein peripheral lip 58 fits around portion 40 of peripheral lip 36 and is held by friction. Complementary threads or ridges could be used, rather than relying on a friction fit. When base 10 and cover 20 are assembled in this fashion, an interior chamber, designated by reference numeral 60 in FIG. 4, is formed. It is into this chamber that excess milk seeping from the breast is collected. Cover 20 does not contact the nipple that passes through aperture 34. Thus, the nipple is shielded from possibly irritating contact with the wearer's clothing.

Cover 20 has an orifice 64, typically ⅛ inch in diameter. Surrounding orifice 64 and extending from concave chamber defining surface 50 inwardly to the interior of chamber 60 is tube 70. Tube 70, which typically has the same inside diameter as the diameter of orifice 64 may be aligned parallel to cylindrical axis of symmetry 68.

By reference to FIGS. 5*a* through 5*d*, the leakage inhibiting function of tube 70 will be understood. FIGS. 5*a* through 5*d* are sectional views of chamber 60, partially filled with milk. In FIG. 5*a* the breast shield is vertical with orifice 64 near the top. This is the position that the breast shield would assume under normal conditions when being worn by a nursing woman. This position presents no danger of leakage, and tube 70 is not required to prevent the flow of milk out of the chamber.

FIG. 5*b* illustrates a breast shield having an orifice 64 without a surrounding tube, when the breast shield is in a horizontal position. This orientation occurs when a woman wearing the breast shield bends over or lies down on her stomach. Milk 80 runs out of orifice 64 as a stream or series of drops 82.

FIG. 5*c* shows a breast shield according to this invention when it is in the same horizontal position as that shown in FIG. 5*b*. Tube 70 surrounding orifice 64 extends beyond the level of accumulated milk, thereby preventing milk from flowing out of orifice 64.

FIG. 5*d* illustrates the breast shield of this invention with the orifice and tube at the lowest position. Thus, should the user wish to recover the milk accumulated in the chamber, all she need do is orient the breast shield so that tube 70 is entirely below the surface of the accumulated milk. In this orientation, milk 80 flows through tube 70 and out of orifice 64 in a stream or series of drops 82.

What is claimed is:

1. In a generally circular breast shield for nursing women, said breast shield including a substantially round base having a first concave breast-confronting surface, a second convex chamber-defining surface, and a first peripheral lip surrounding said convex chamber-defining surface, said base having a centrally located nipple-receiving aperture communicating between said first breast-confronting surface and said second chamber-defining surface, said base having a cylindrical symmetry axis that is generally horizontal when said breast shield is in use on a non-reclining woman, said breast shield also including a substantially round cover having a first concave chamber defining surface, a second peripheral lip surrounding said first concave chamber-defining surface, and a second outer convex surface, said cover having a non-centrally located orifice communicating between said first chamber defining surface and said outer surface, said base and said cover being connectable by engagement of said peripheral lips to provide an inner milk receiving chamber, said breast shield in use on a non-reclining woman being disposed generally vertically with said orifice at an elevation above said aperture, the improvement comprising:

a straight tube sealingly mounted to said cover and surrounding said orifice, said tube extending away from said first concave chamber defining surface of said cover into said chamber in a direction generally parallel to said cylindrical symmetry axis said tube having sufficient length to prevent milk accumulated within said chamber from flowing through said orifice when said breast shield is tilted horizontally so that said milk surrounds said orifice, said orifice being positioned sufficiently close to the periphery of said chamber to allow a major portion of said milk to flow through said tube and said orifice when said breast shield is vertically disposed with said orifice at an elevation below said aperture.

2. The invention of claim 1 wherein said tube and said cover are of one-piece construction.

* * * * *

US007223255B2

(12) **United States Patent**
Myers et al.

(10) **Patent No.: US 7,223,255 B2**
(45) **Date of Patent: May 29, 2007**

(54) **SYSTEM FOR A PORTABLE HANDS-FREE BREAST PUMP AND METHOD OF USING THE SAME**

(75) Inventors: **Kenneth E. Myers**, Marietta, GA (US); **Ellen Lundy**, Woodstock, GA (US); **Drew F. Meincke**, Woodstock, GA (US); **Sharon Birdseye**, Marietta, GA (US)

(73) Assignee: **Whisper Wear Inc.**, Marietta, GA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 578 days.

(21) Appl. No.: **10/173,655**

(22) Filed: **Jun. 19, 2002**

(65) **Prior Publication Data**

US 2002/0193731 A1 Dec. 19, 2002

(51) **Int. Cl.**
A61M 1/06 (2006.01)

(52) **U.S. Cl.** **604/74**

(58) **Field of Classification Search** 604/73, 604/74, 75, 76

See application file for complete search history.

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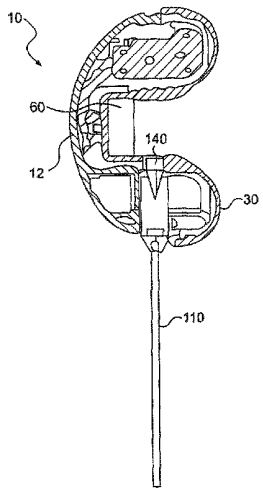
Primary Examiner—Kevin C. Sirmons
Assistant Examiner—Elizabeth MacNeill
(74) *Attorney, Agent, or Firm*—Michael J. Mehrman; Mehrman Law Office PC

(57) **ABSTRACT**

A portable, hands-free and user friendly breast pump for facilitating breast-feeding, incorporates a dome-shaped housing having a servomotor mechanism; a hat-shaped flange having a chamber portion, a brim portion and an outlet, the chamber portion being formed so as to be placed over a nipple on a breast so as to define a chamber between the flange and the breast, and the brim portion being formed to surround the nipple and thereby form a suction seal therebetween; and a one-way venting element formed to operatively communicate with the chamber so as to vent pumped milk from the chamber via the outlet. The housing, the flange and the venting element are connected into an integral device held against the breast and underneath clothing so as to keep the integral device hidden. Breast milk is collected via a plastic collection bag that connects directly with the pump underneath clothing such that the milk is isolated from any contaminants in the air and may be easily stored immediately after being collected.

22 Claims, 35 Drawing Sheets



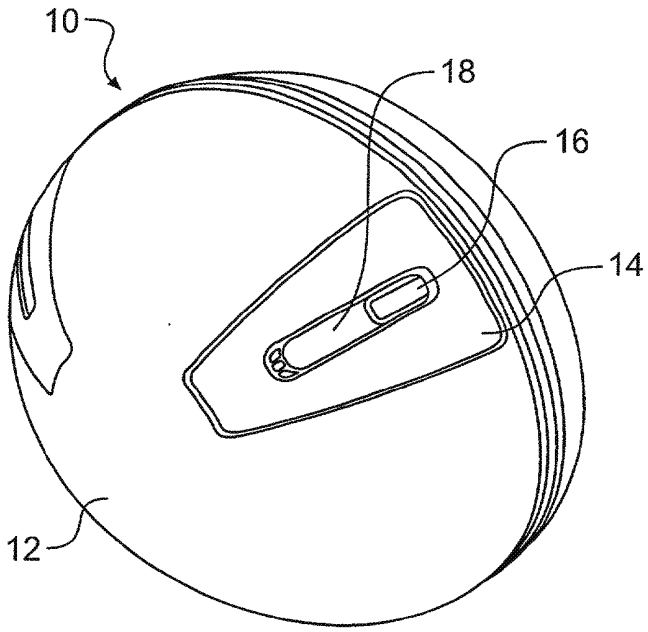


FIG. 1A

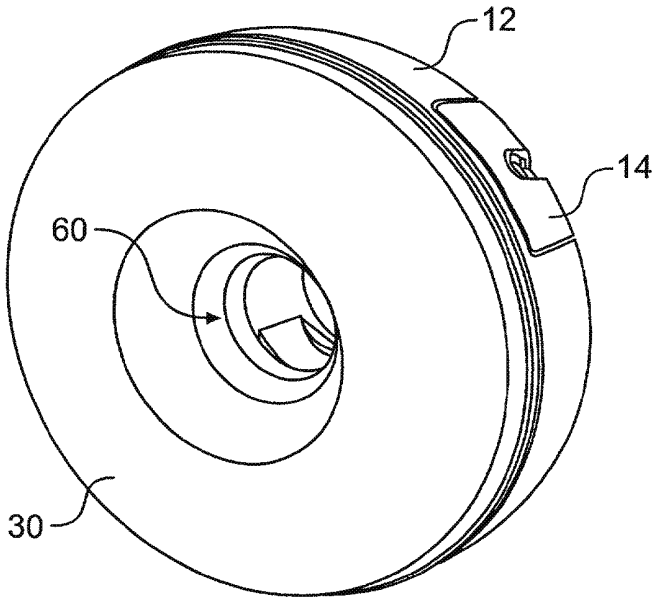


FIG. 1B

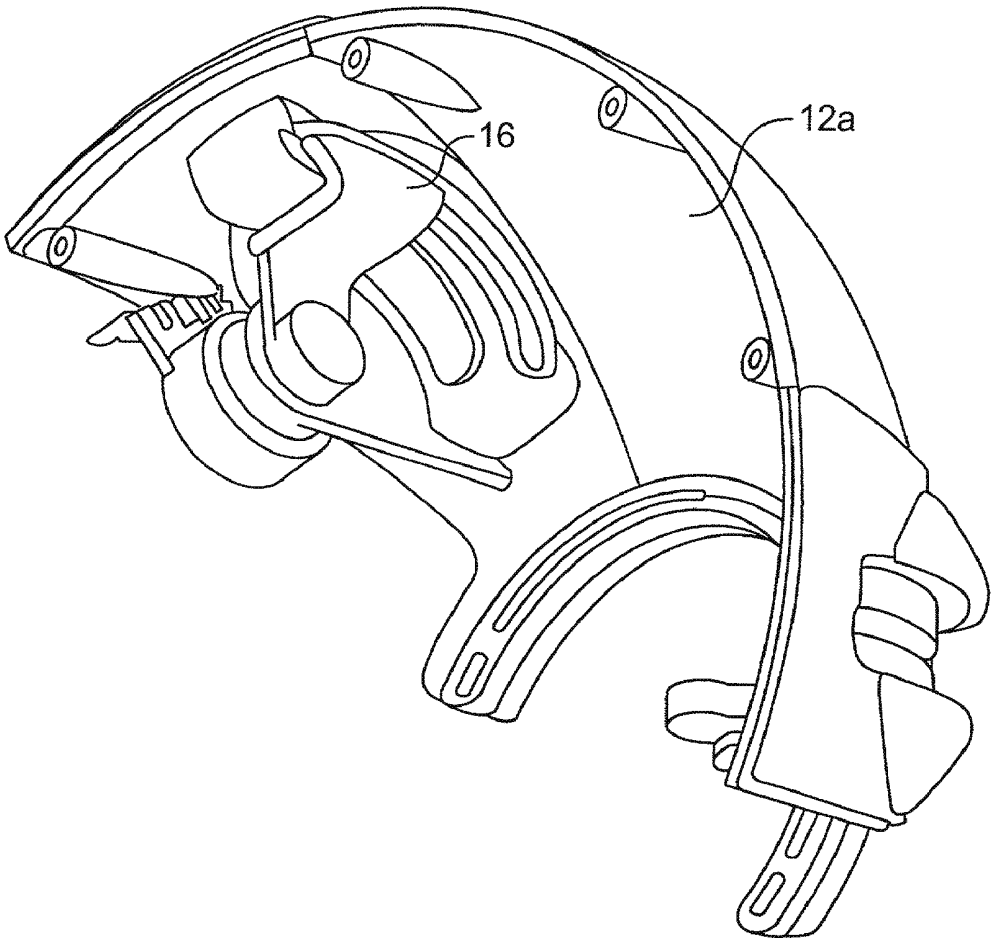


FIG. 2

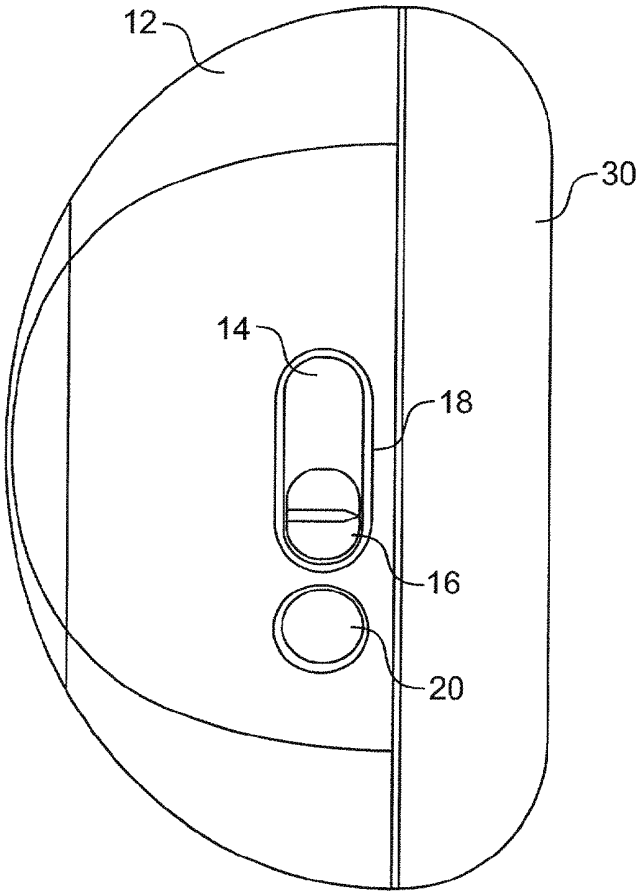


FIG. 3

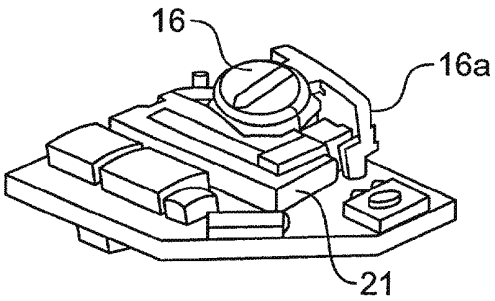


FIG. 4

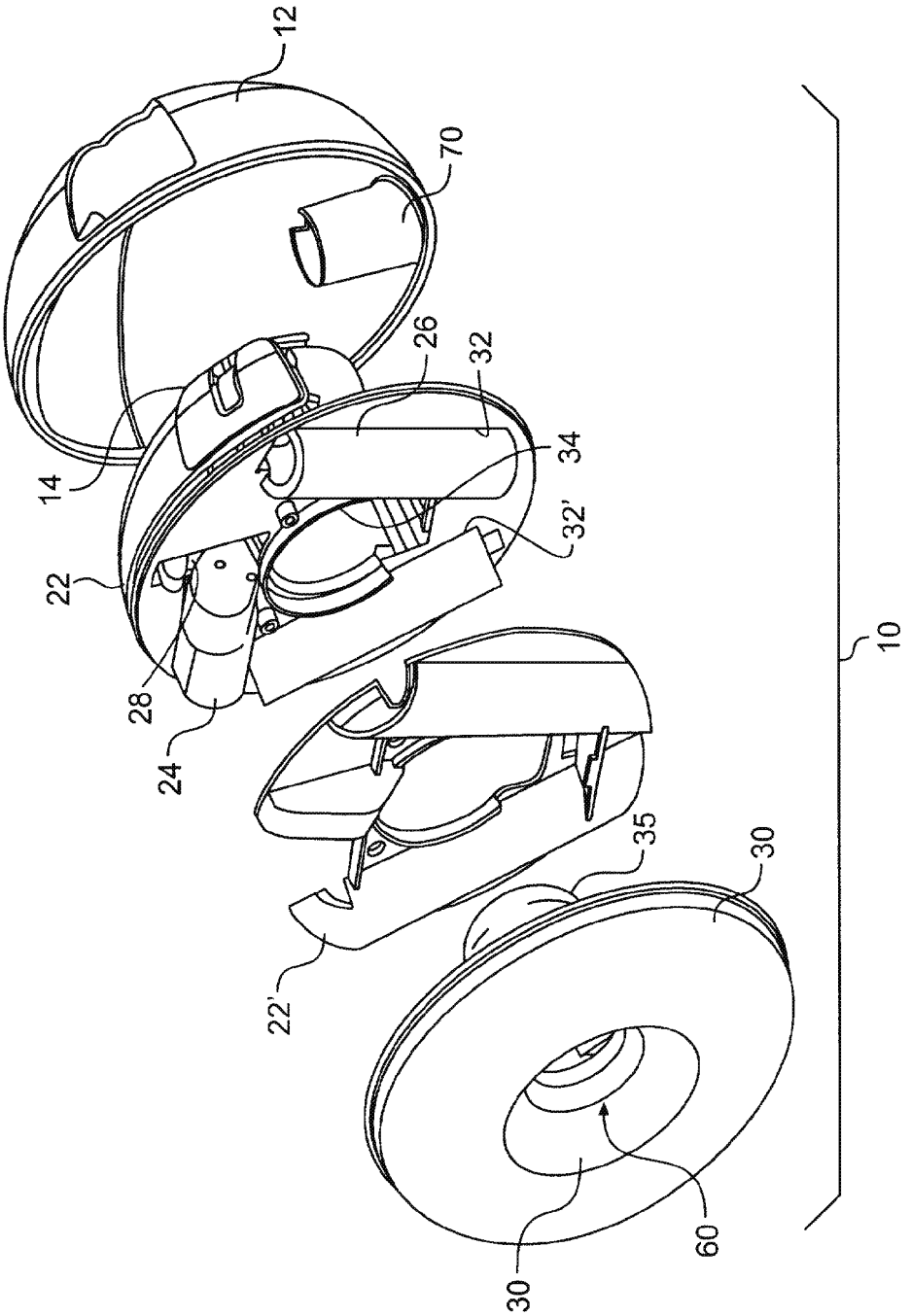


FIG. 5

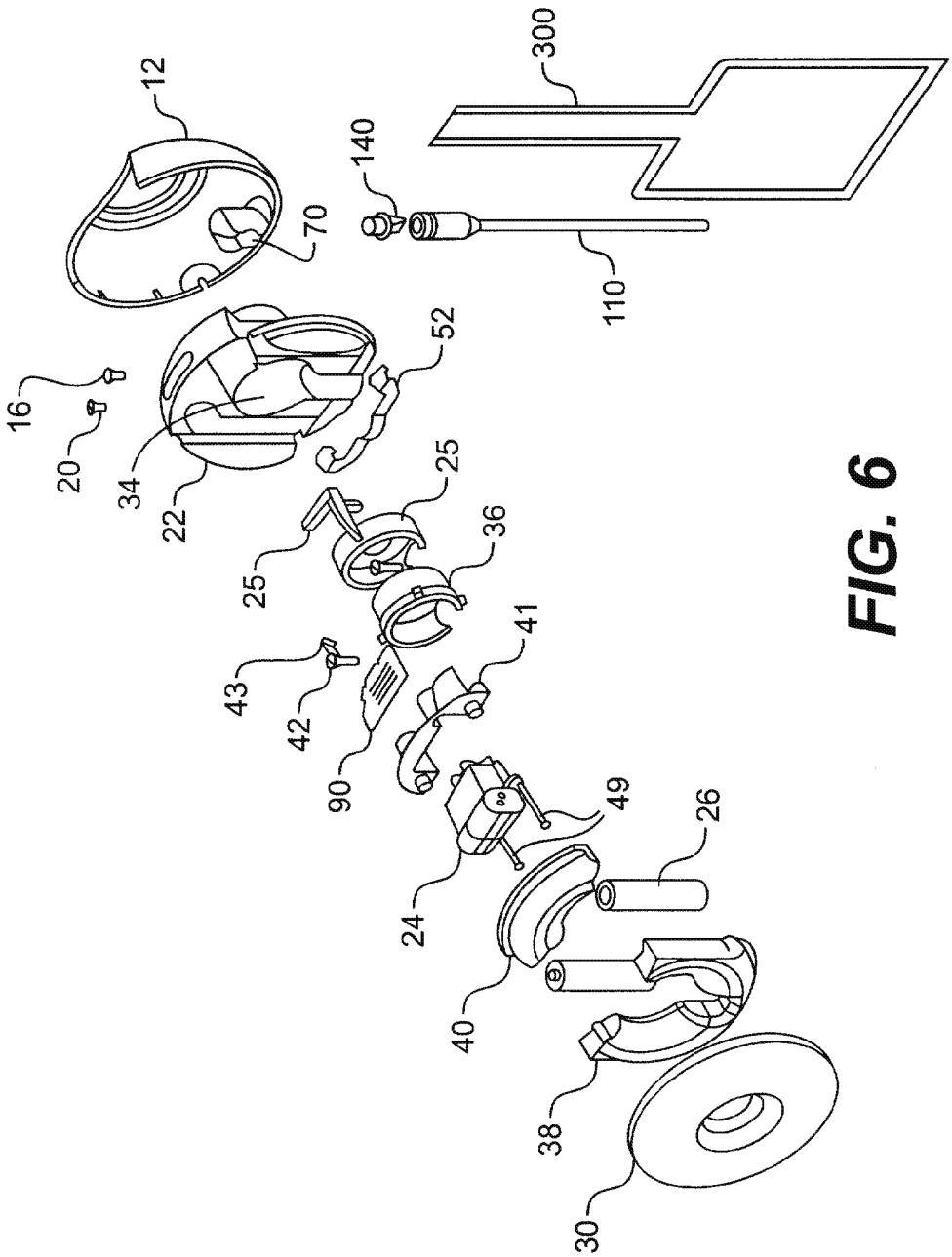


FIG. 6

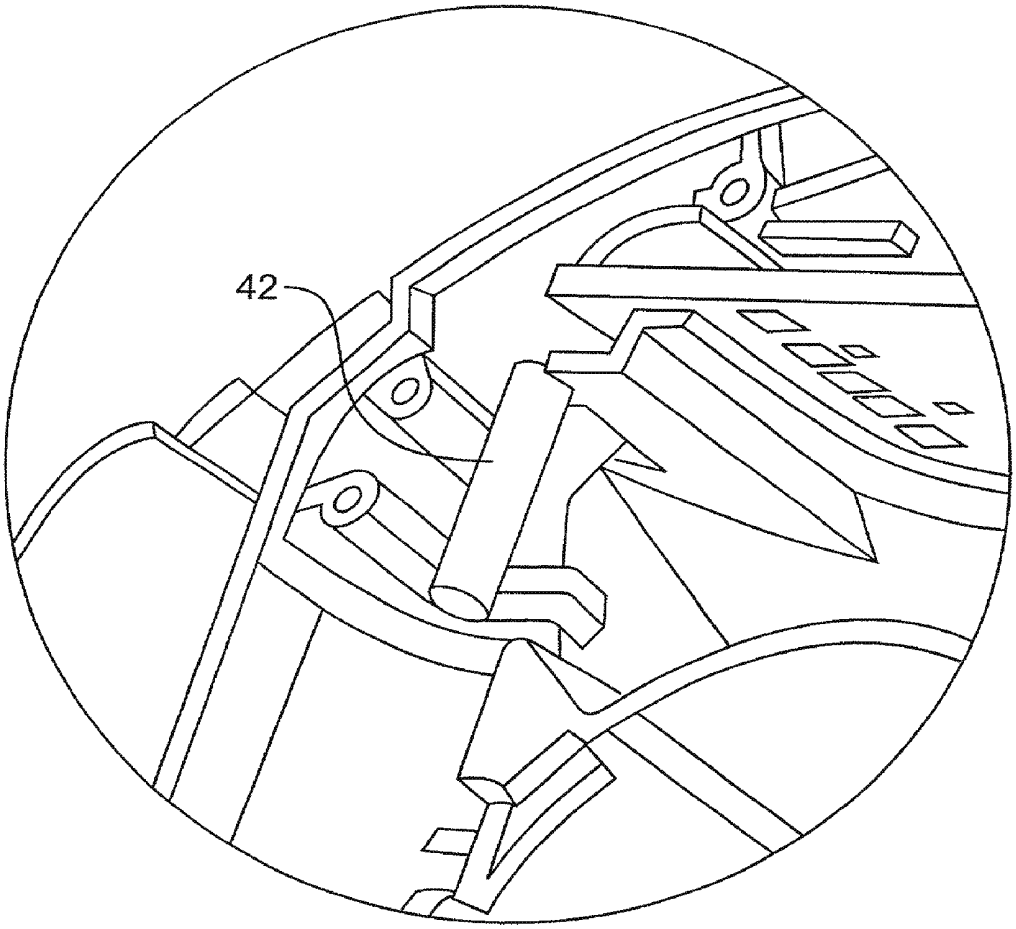


FIG. 7

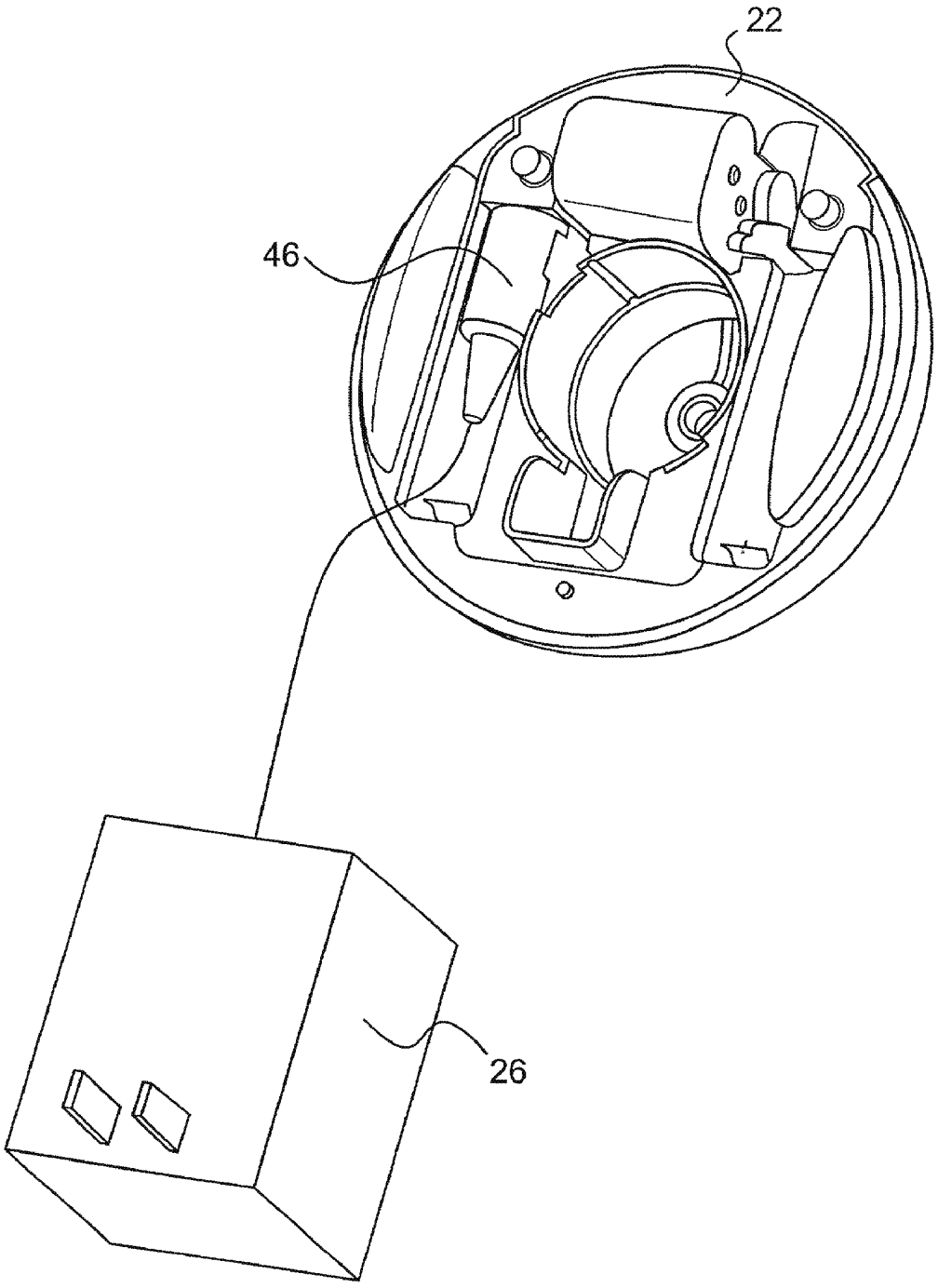


FIG. 8A

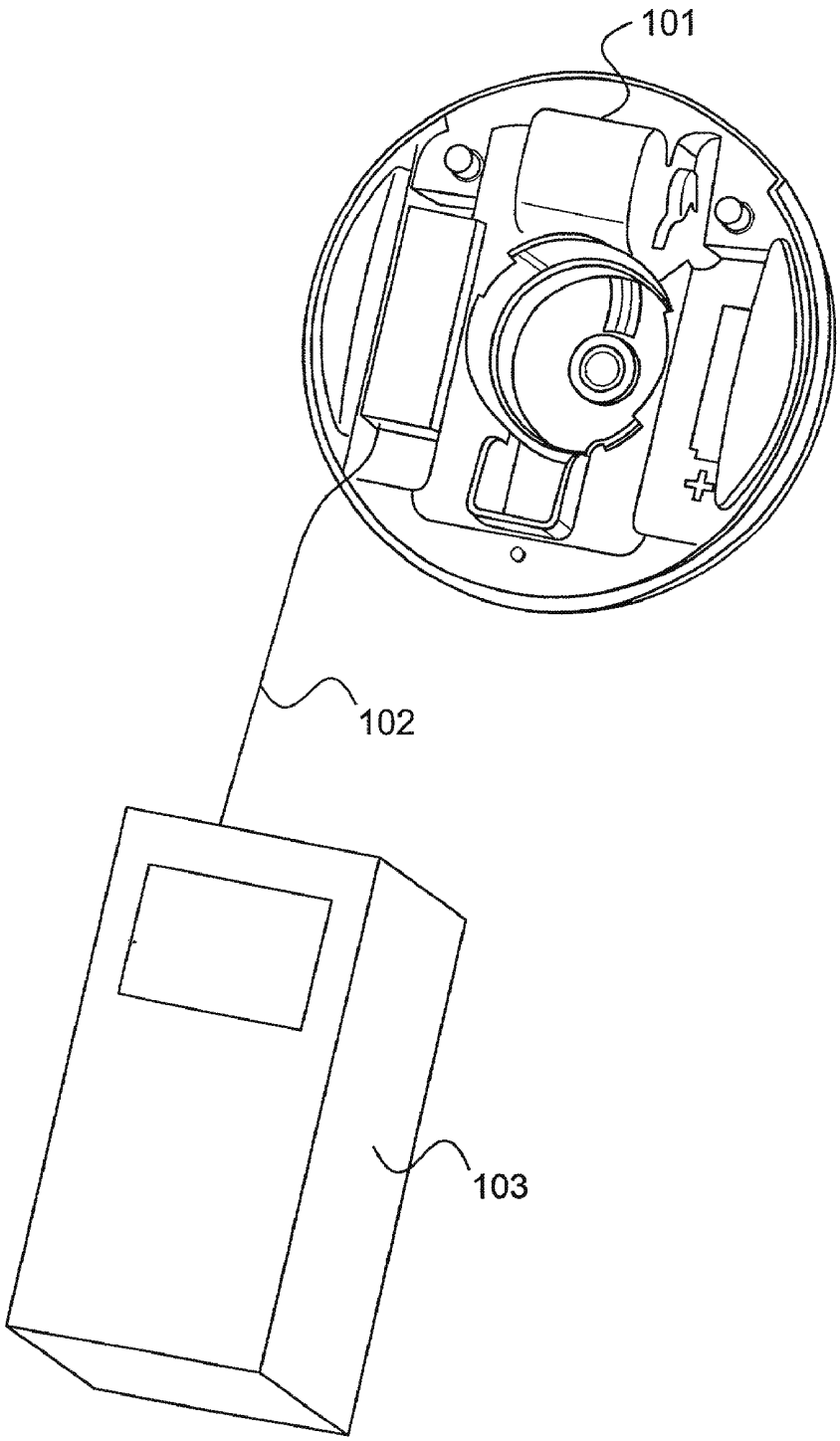


FIG. 8B

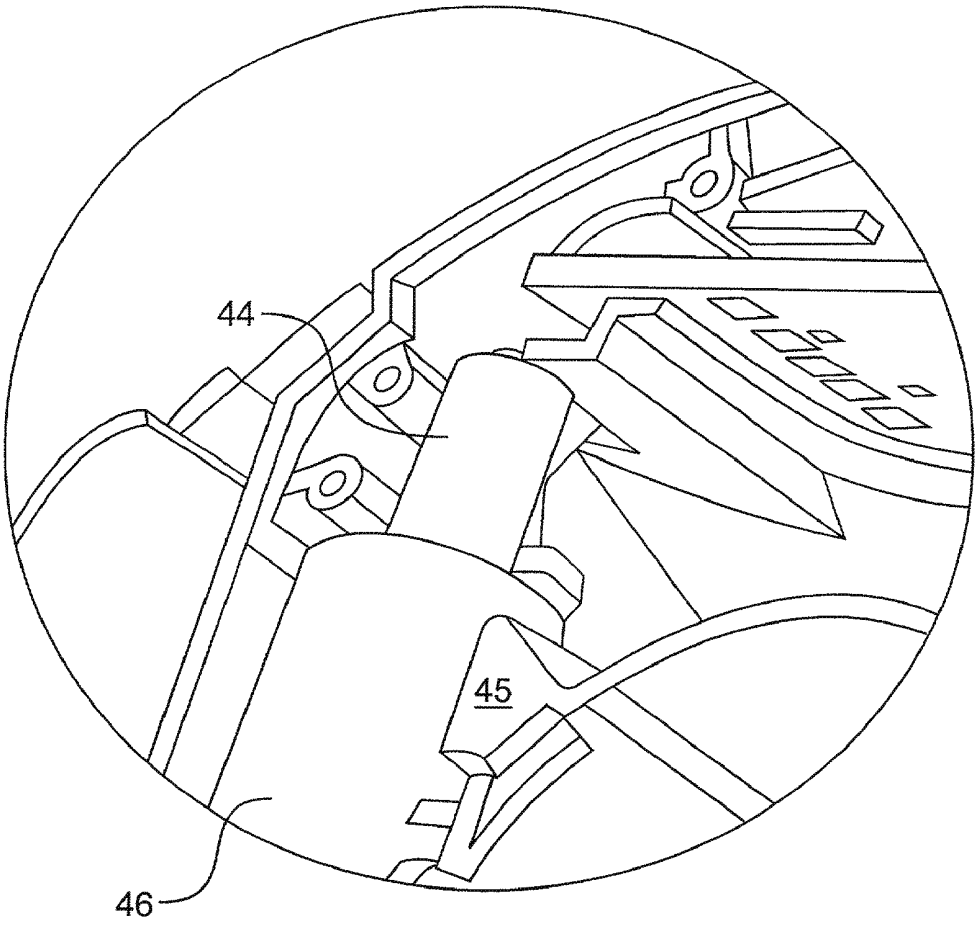


FIG. 9

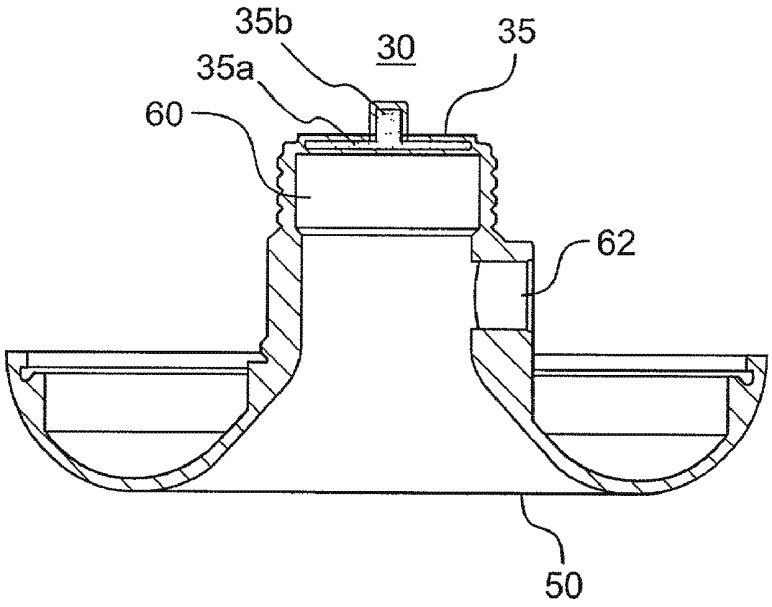


FIG. 10A

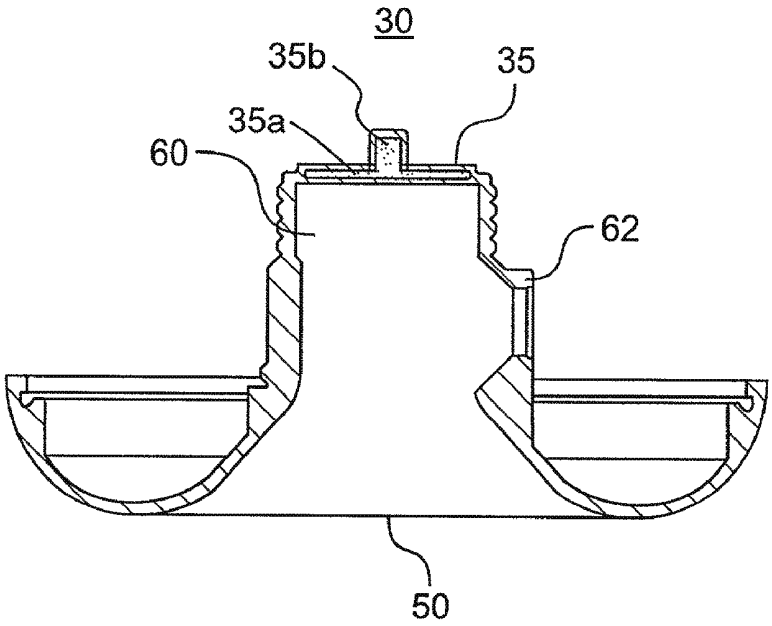


FIG. 10B

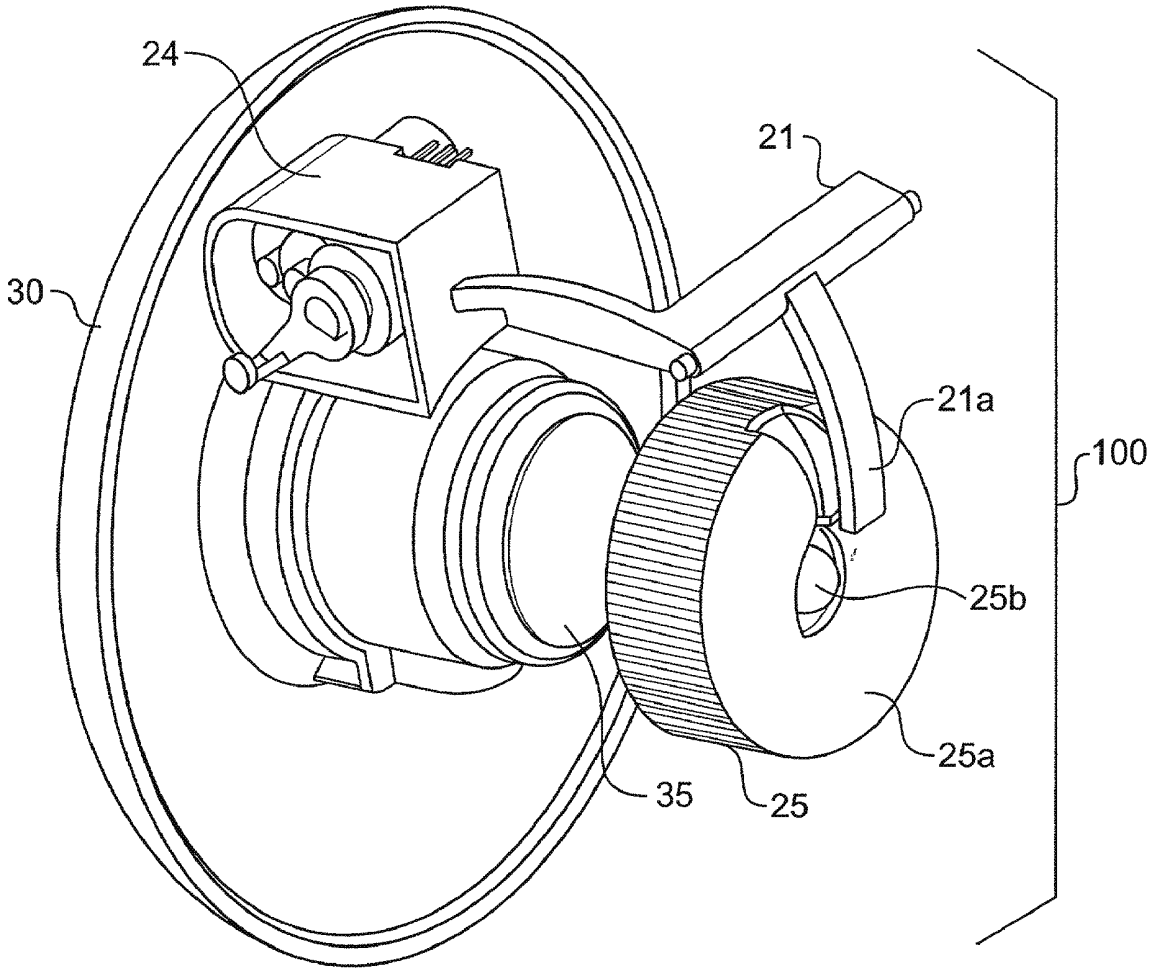


FIG. 11A

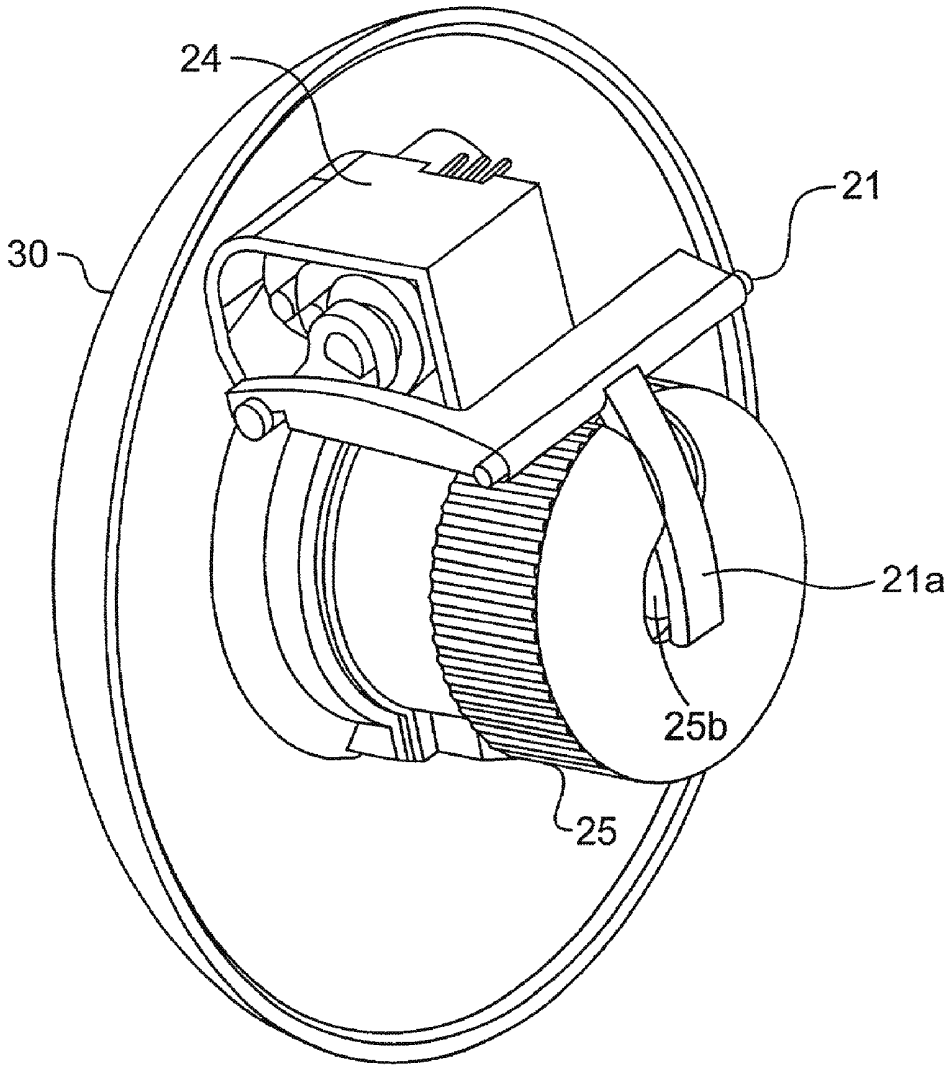


FIG. 11B

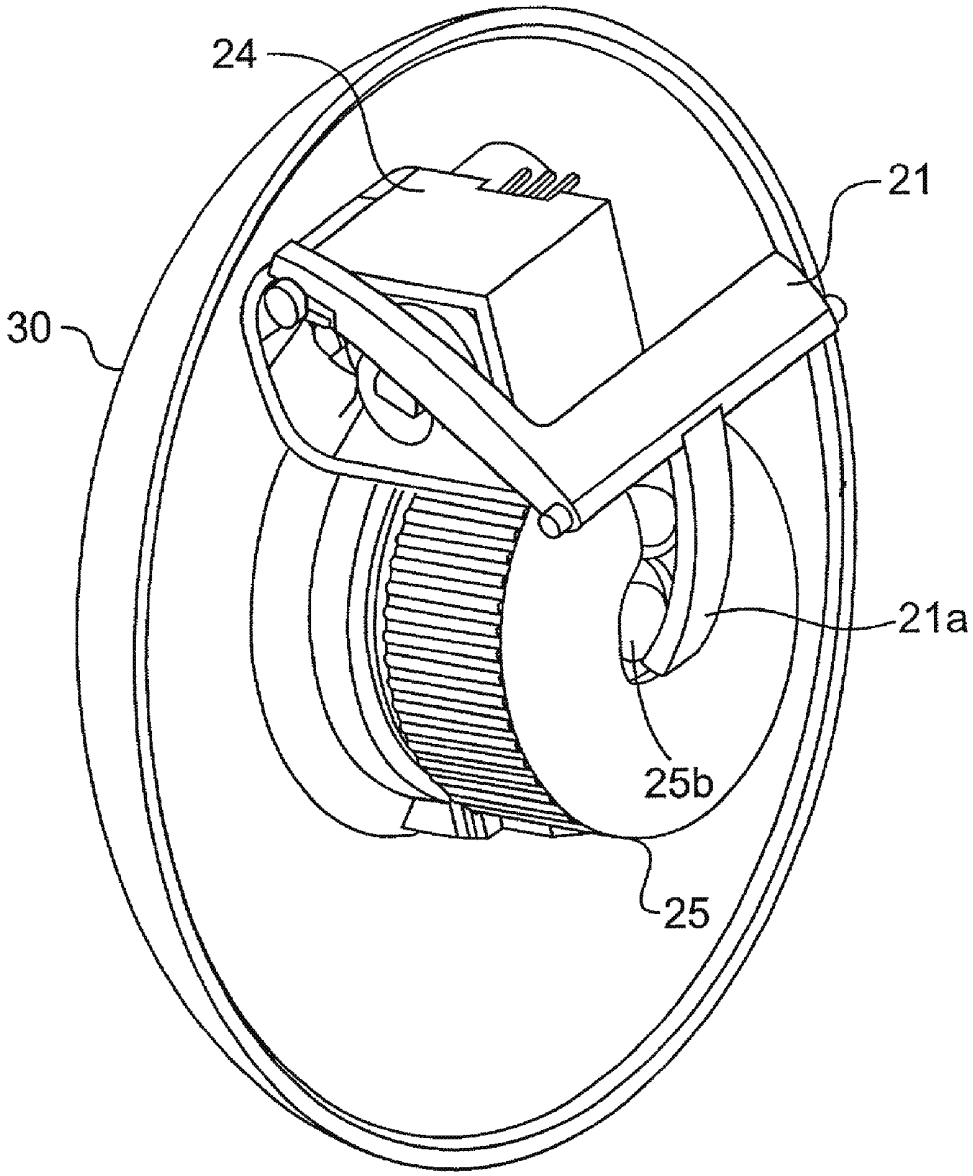


FIG. 11C

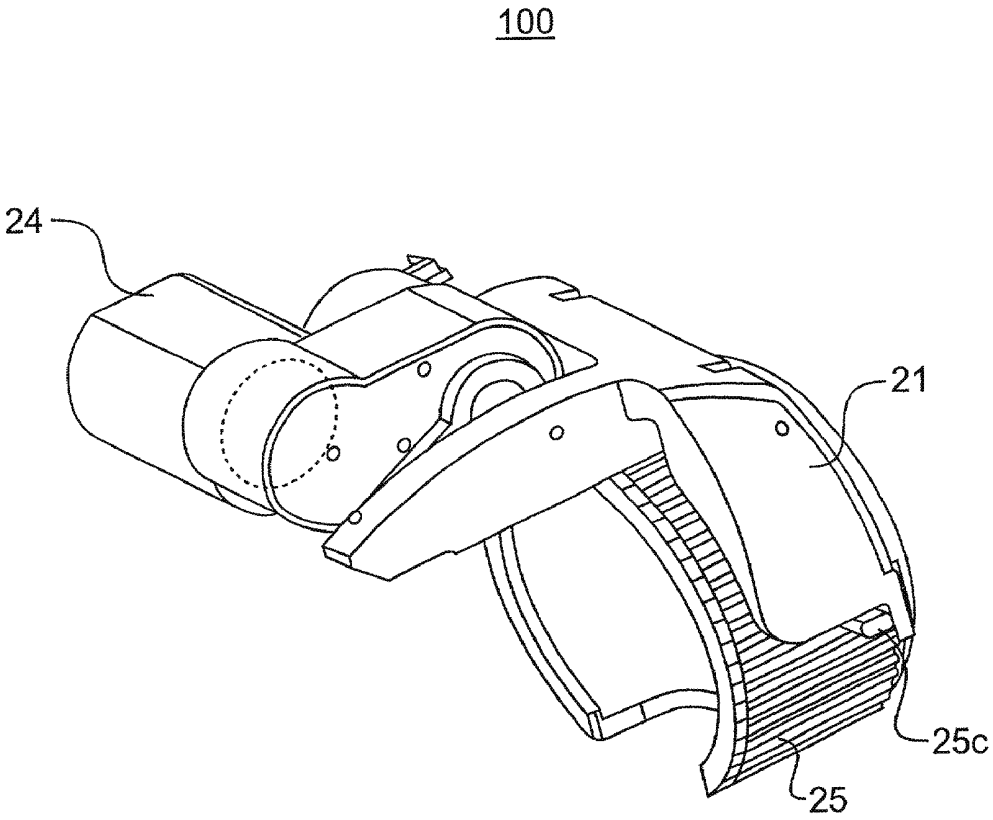


FIG. 12

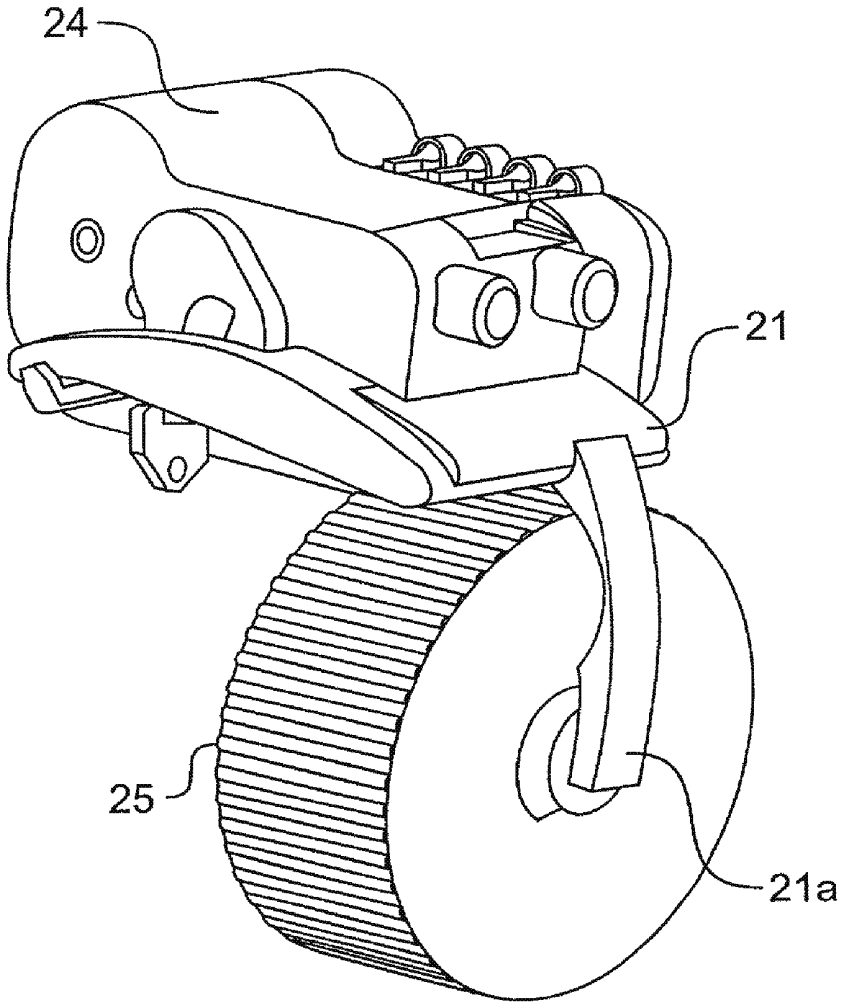


FIG. 13

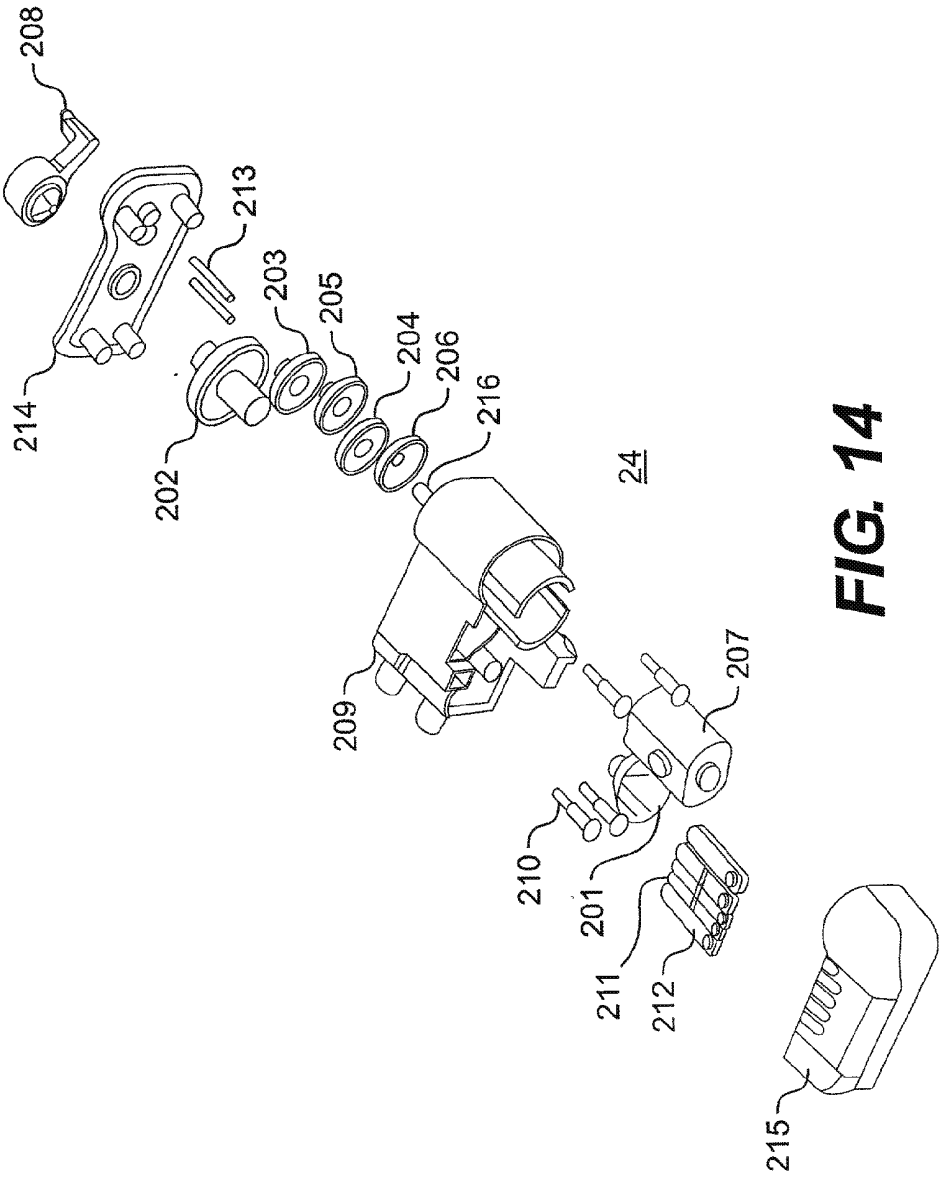


FIG. 14

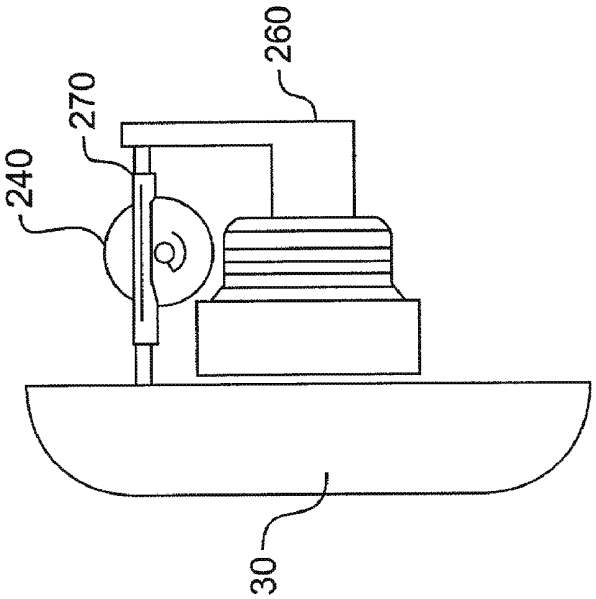


FIG. 16

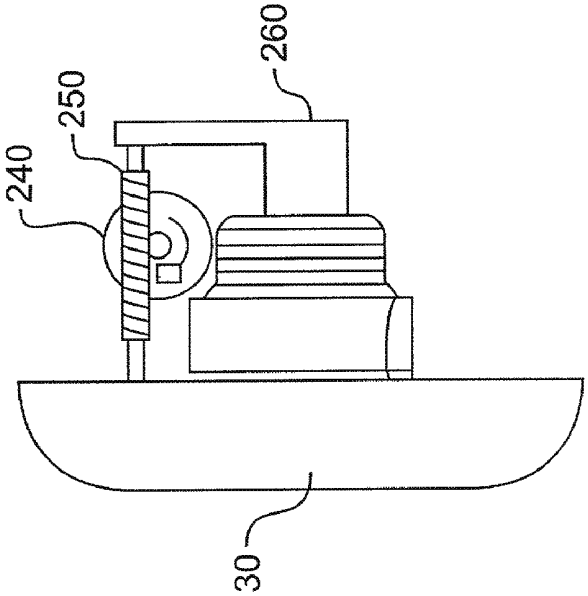


FIG. 15

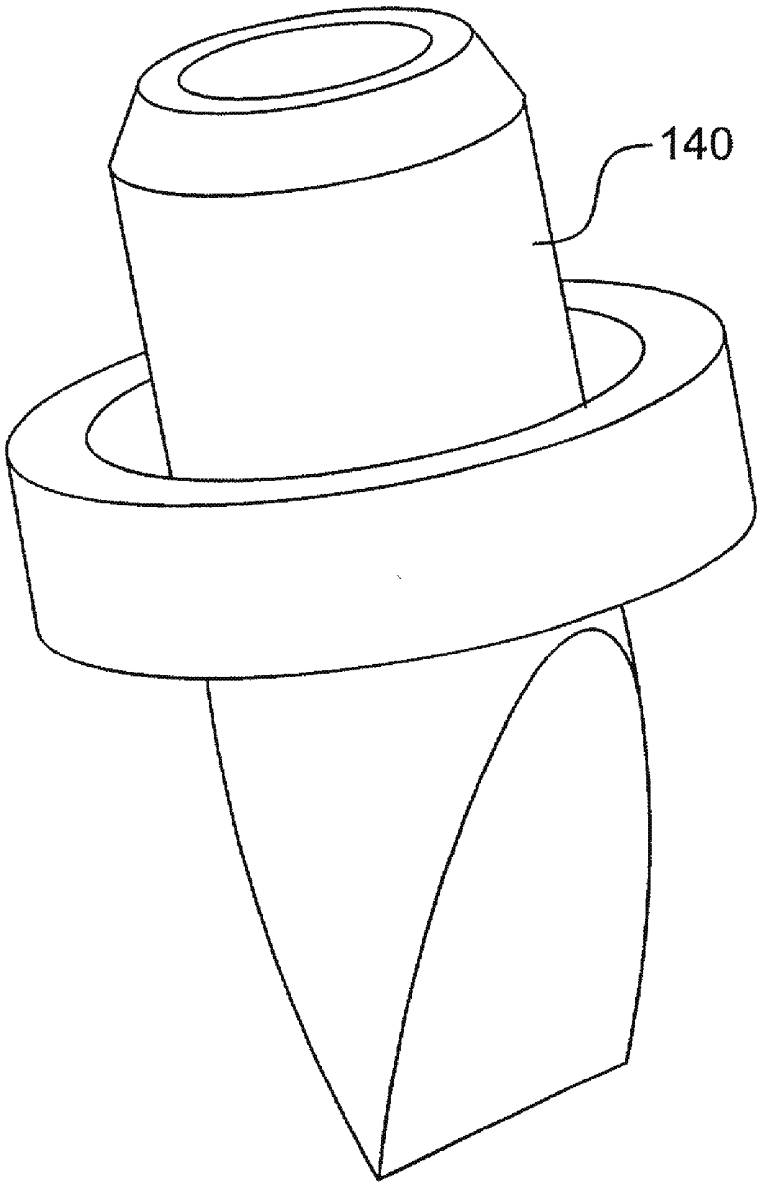


FIG. 17

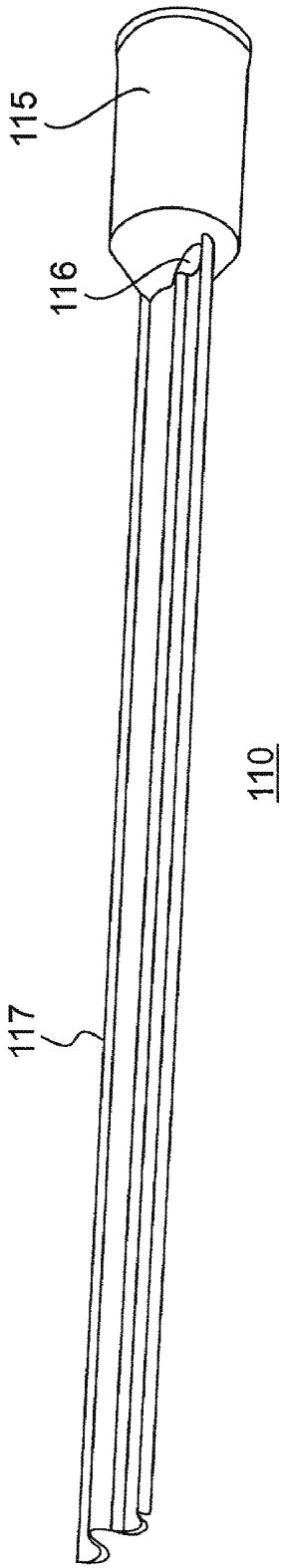


FIG. 18A

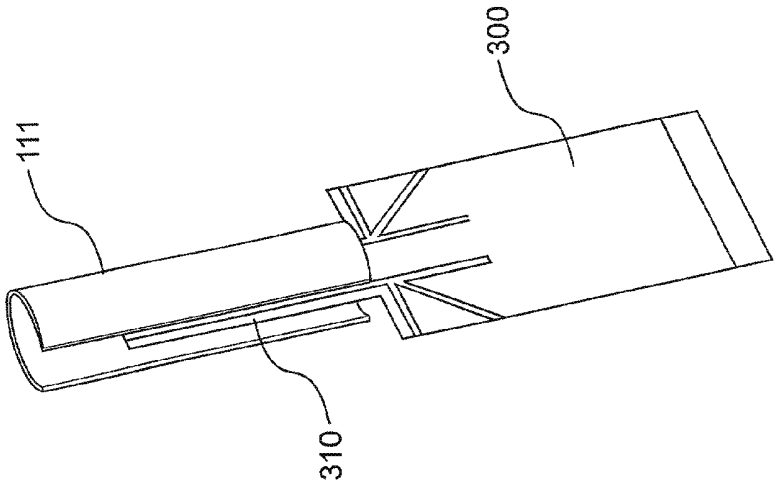


FIG. 18B

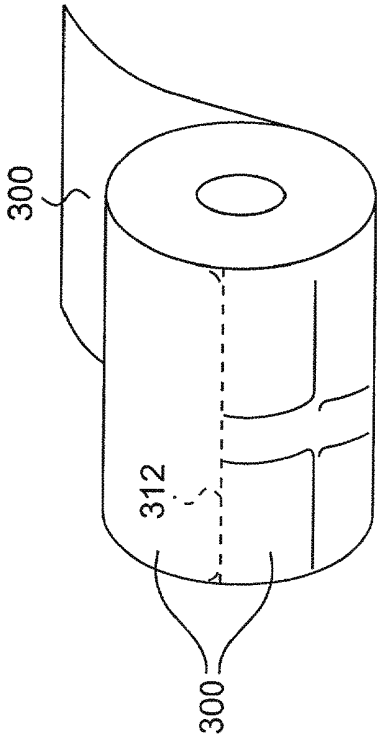


FIG. 19B

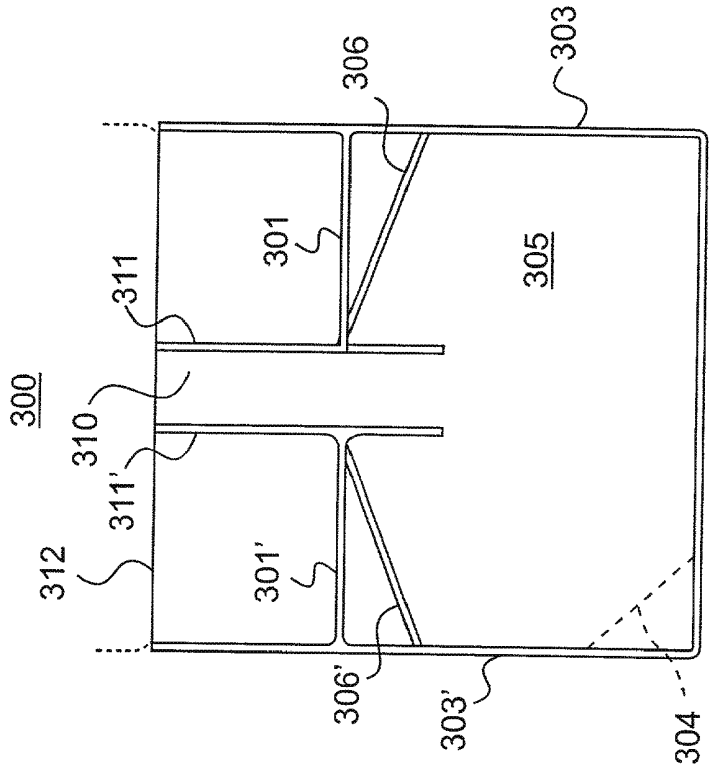


FIG. 19A

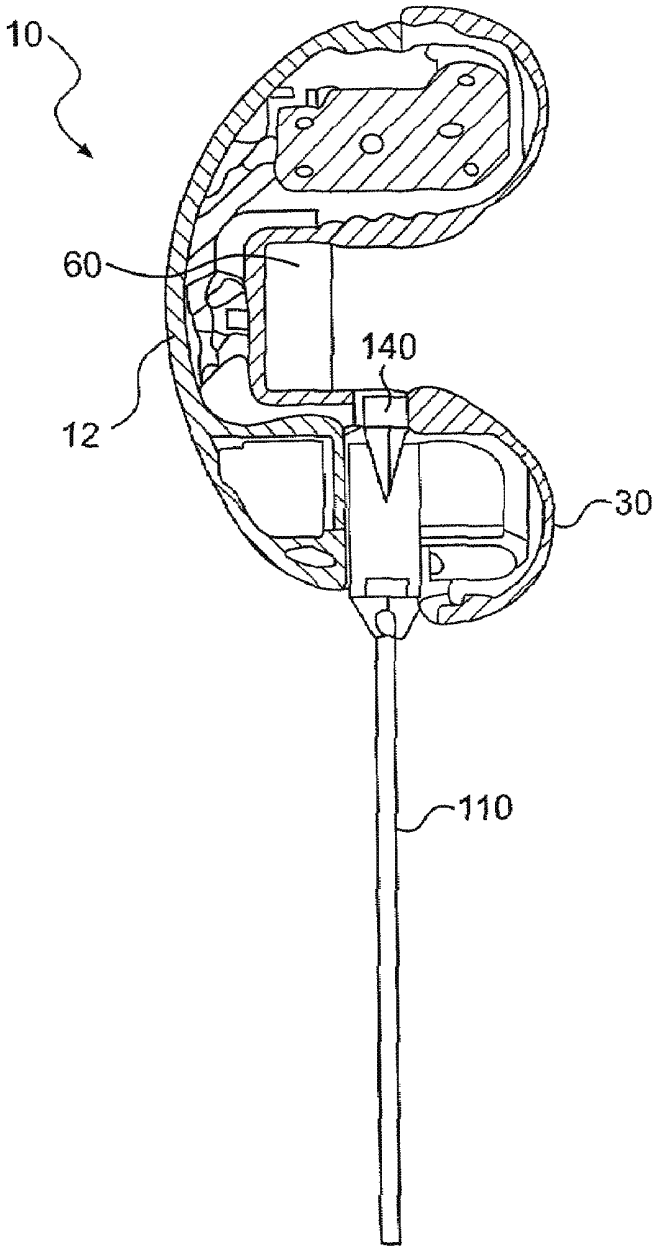


FIG. 20A

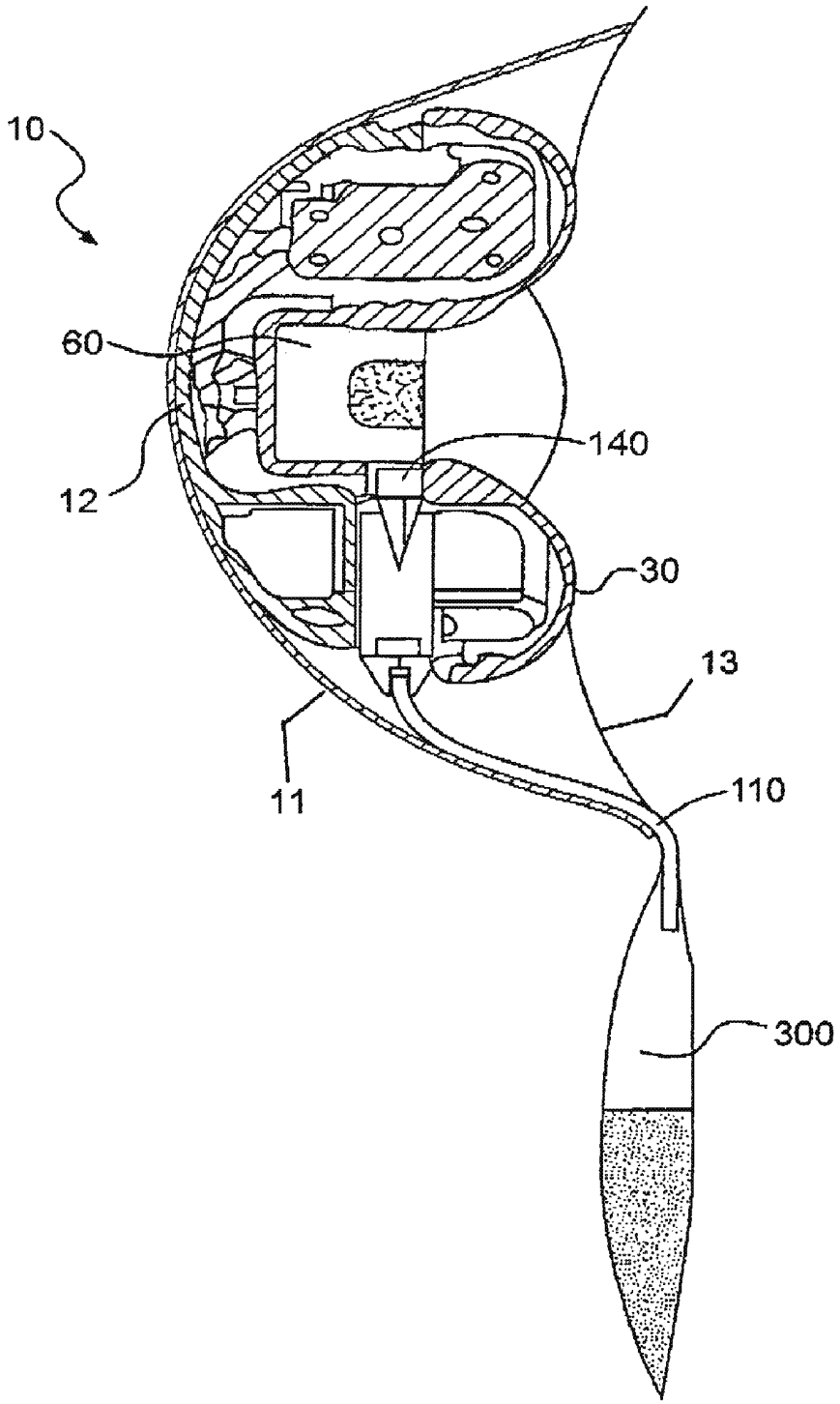


FIG. 20B

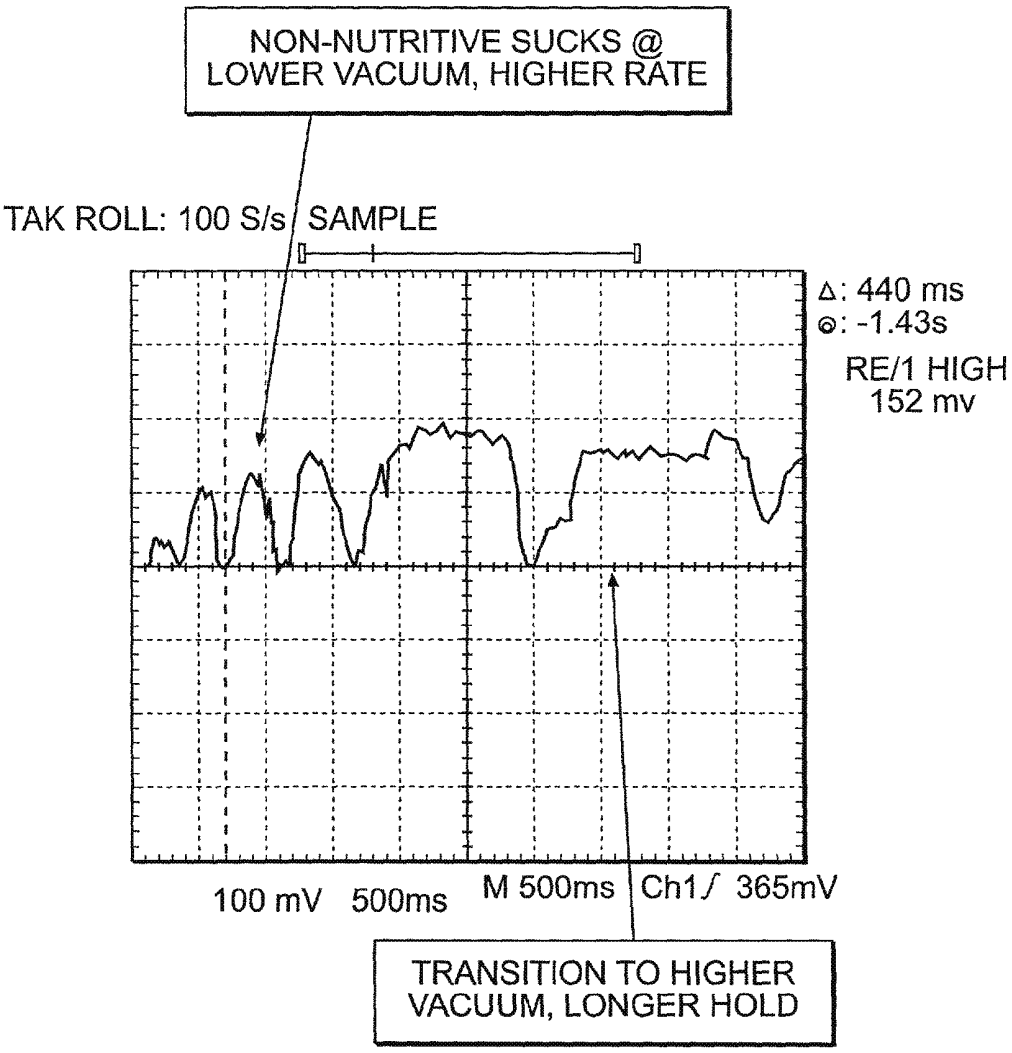


FIG. 21A

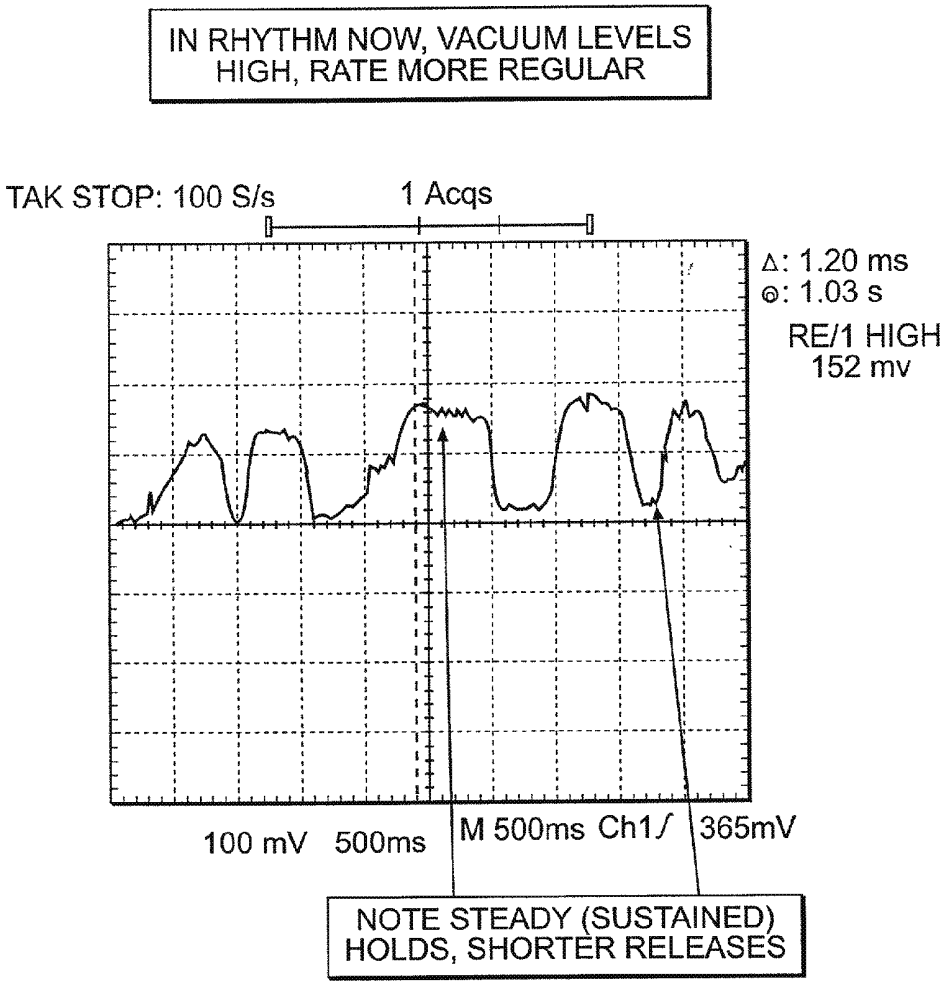


FIG. 21B

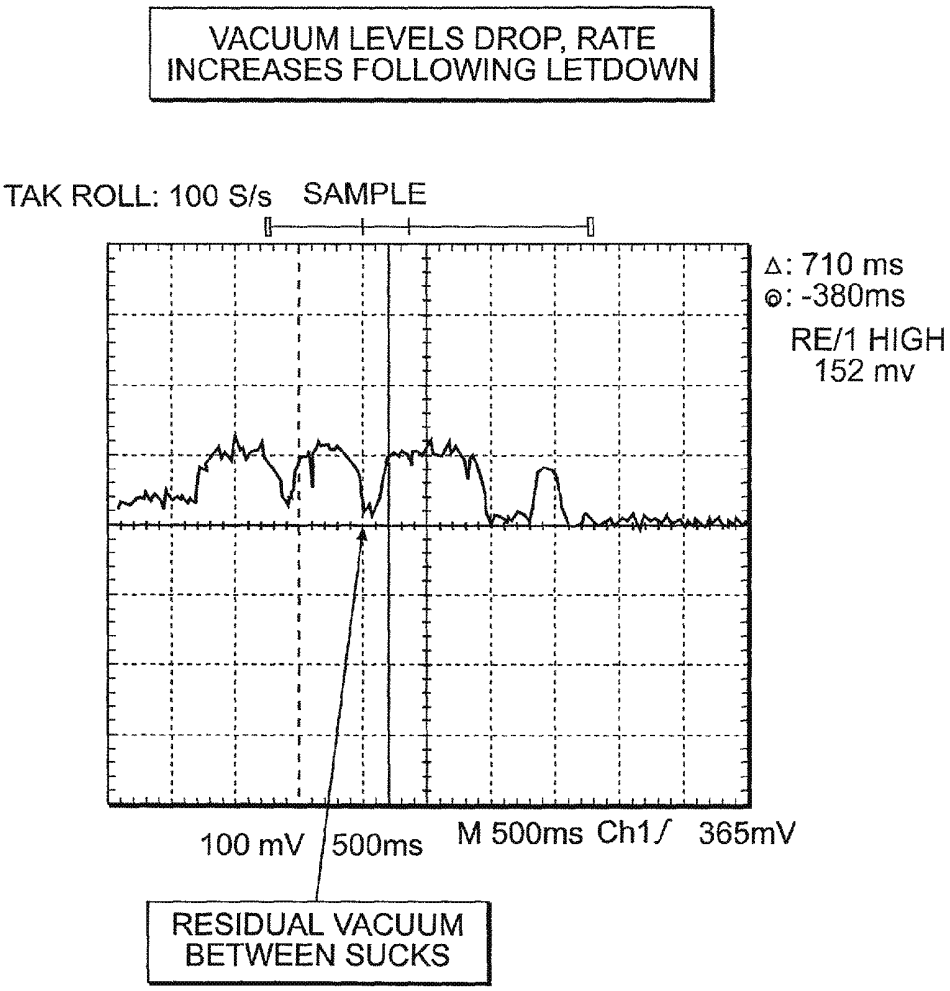
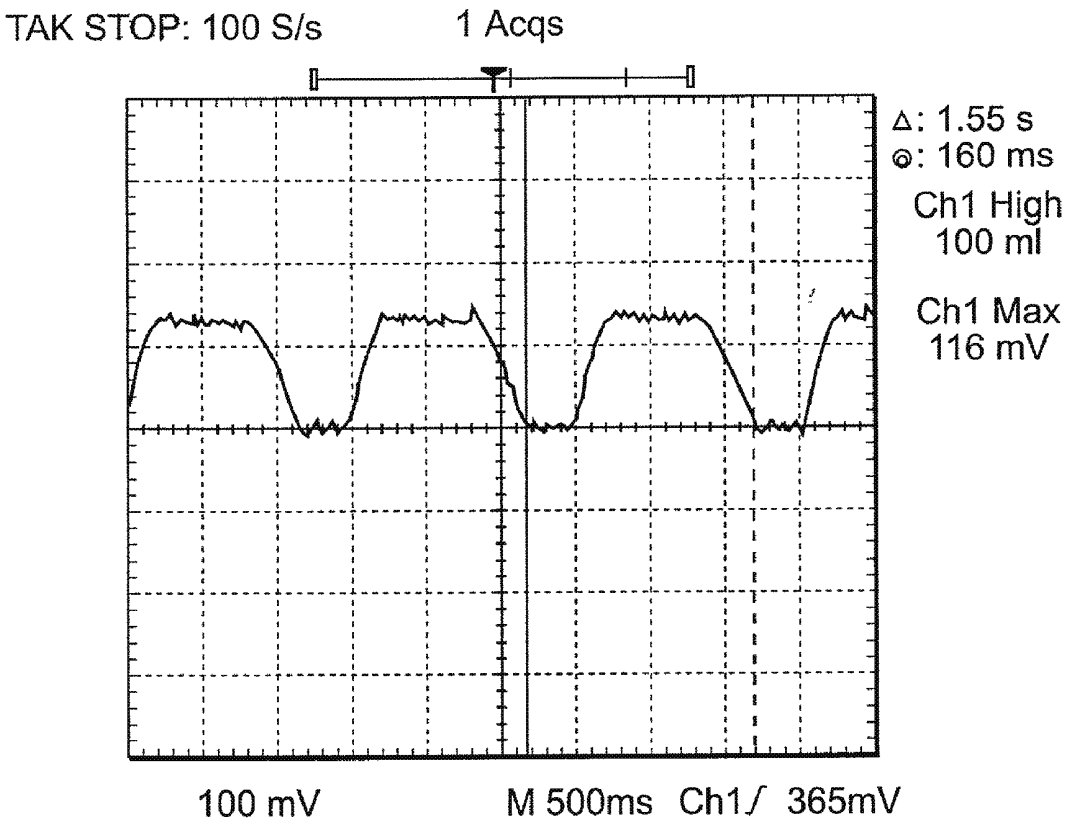
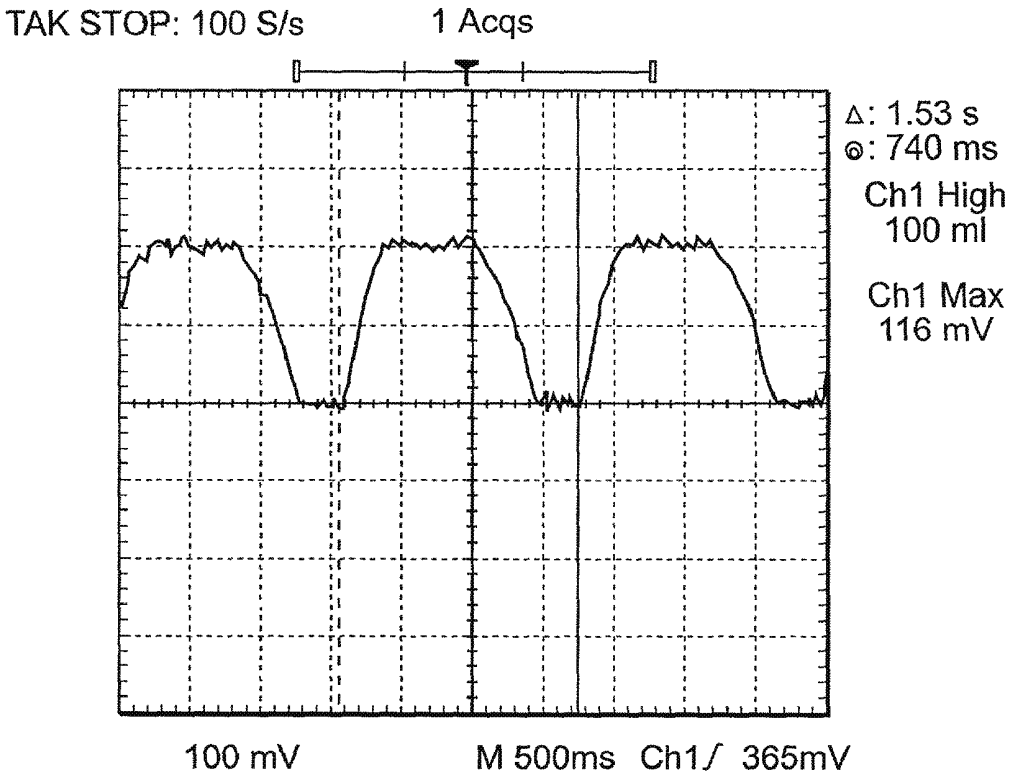


FIG. 21C



Max Vacuum (mmHg):	136
Rate (cyc/min):	39

FIG. 22A



Max Vacuum (mmHg):	204
Rate (cyc/min):	36

FIG. 22B

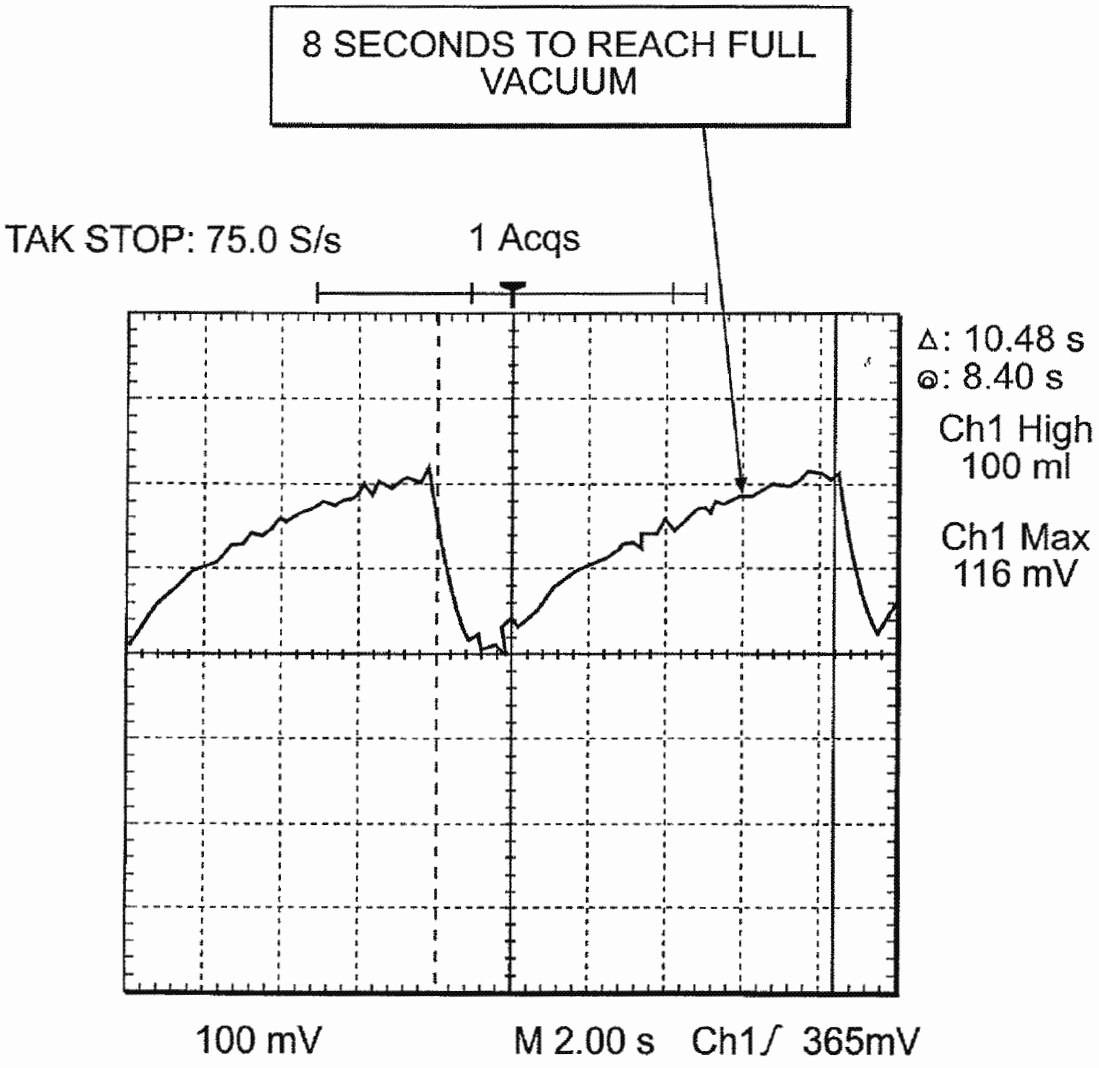


FIG. 23
PRIOR ART

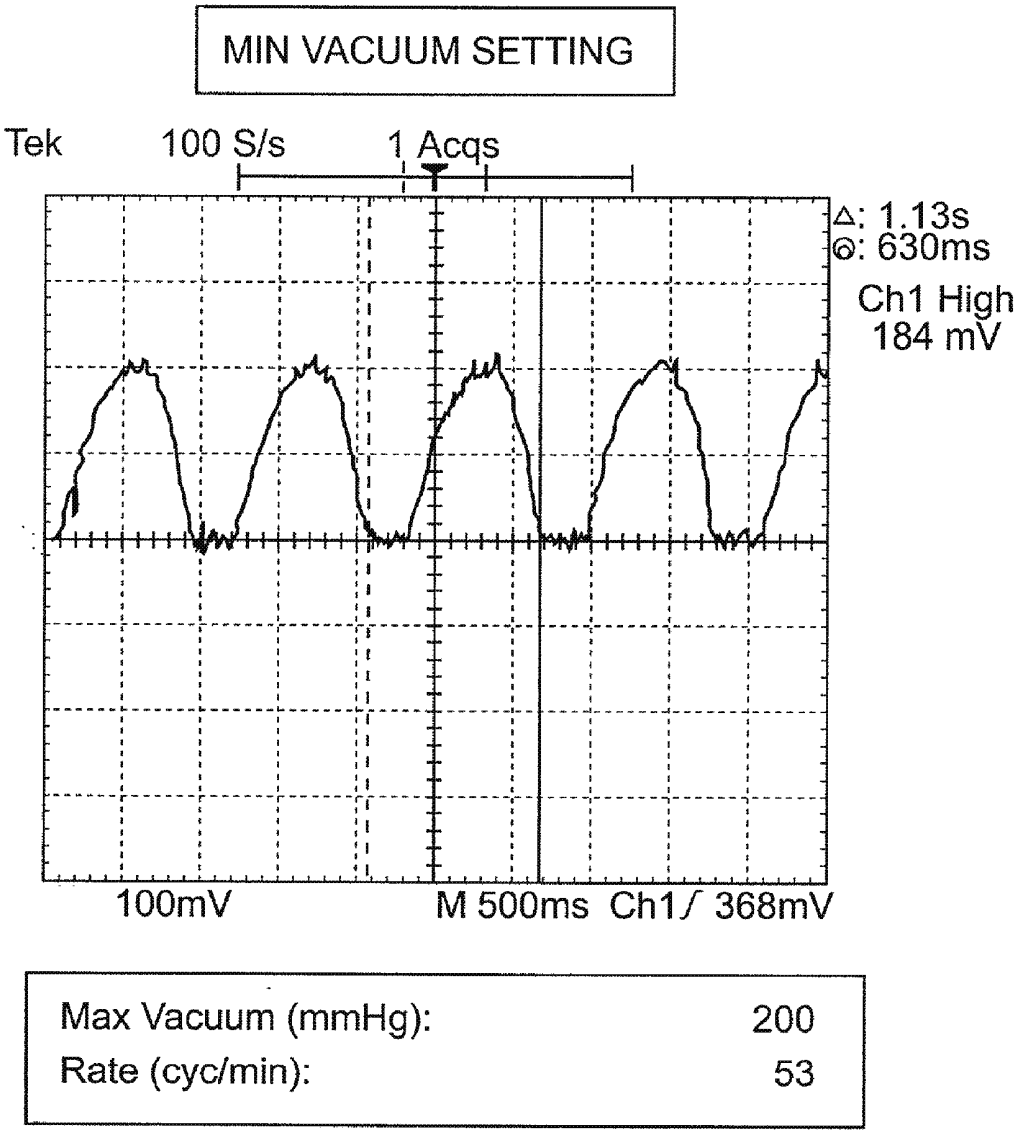


FIG. 24A
PRIOR ART

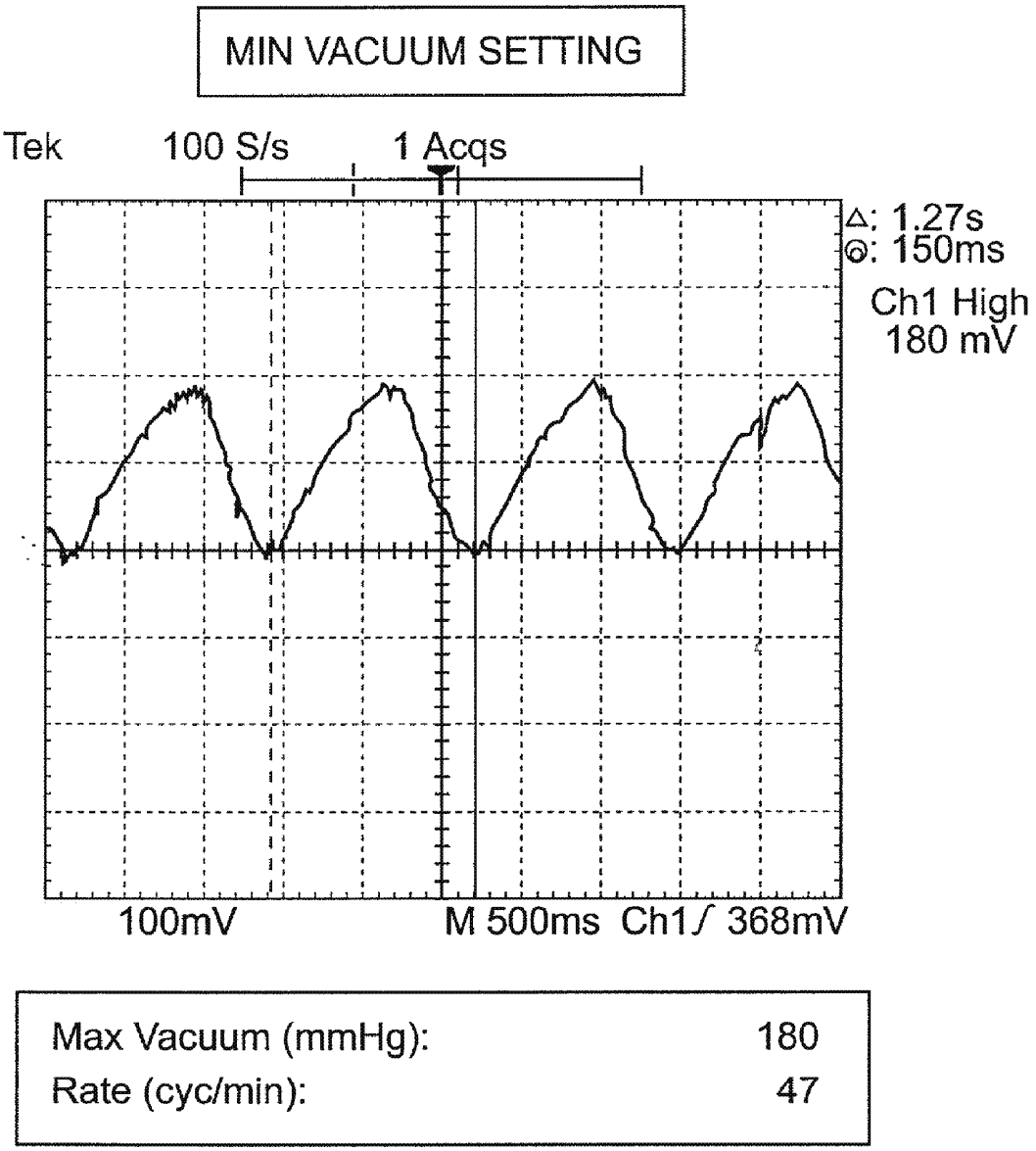
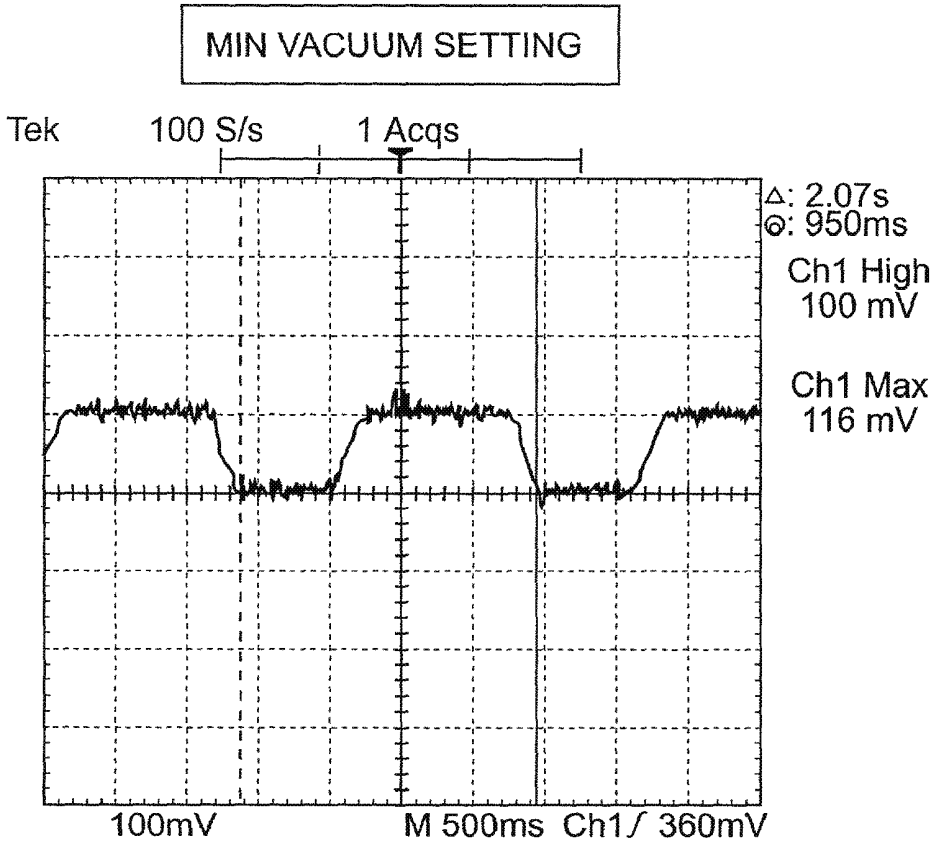


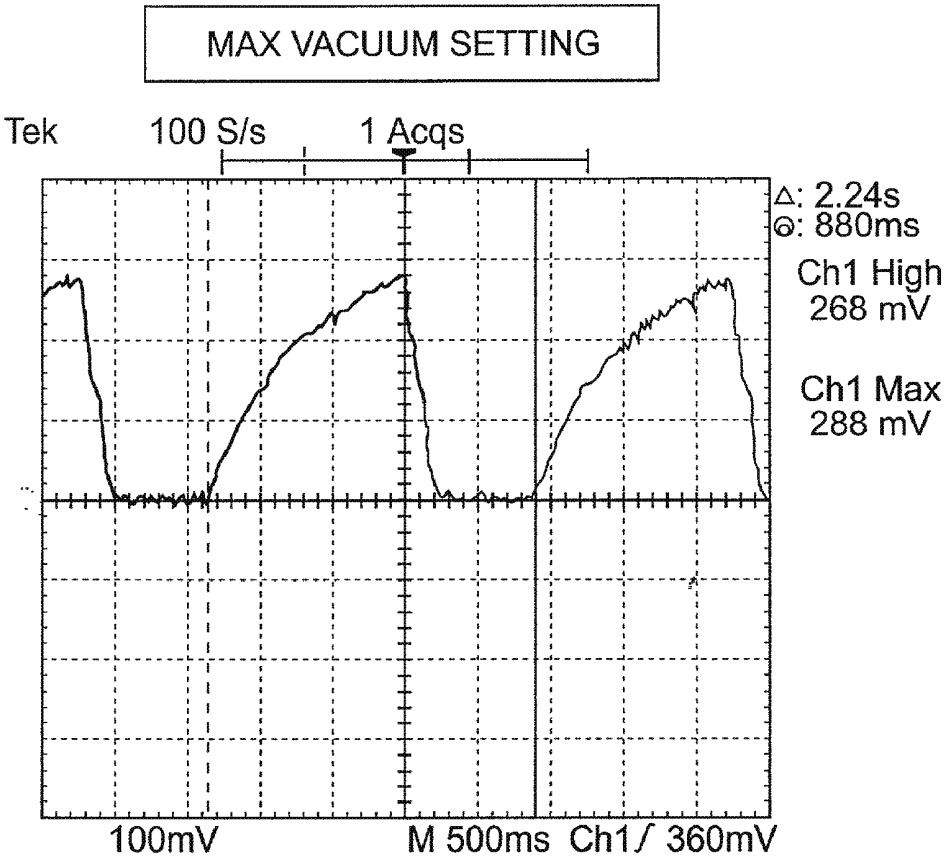
FIG. 24B
PRIOR ART



Max Vacuum (mmHg):	100
Rate (cyc/min):	29
>100 mmHg Hold (sec):	1
<50 mmHg Release (sec):	.9

Pump Settings:	
Vacuum:	Min
Cycles:	N/A

FIG. 25A
PRIOR ART



Max Vacuum (mmHg):	270
Rate (cyc/min):	271
>100 mmHg Hold (sec):	1.4
<50 mmHg Release (sec):	.9

Pump Settings:	
Vacuum:	Max
Cycles:	N/A

FIG. 25B
PRIOR ART

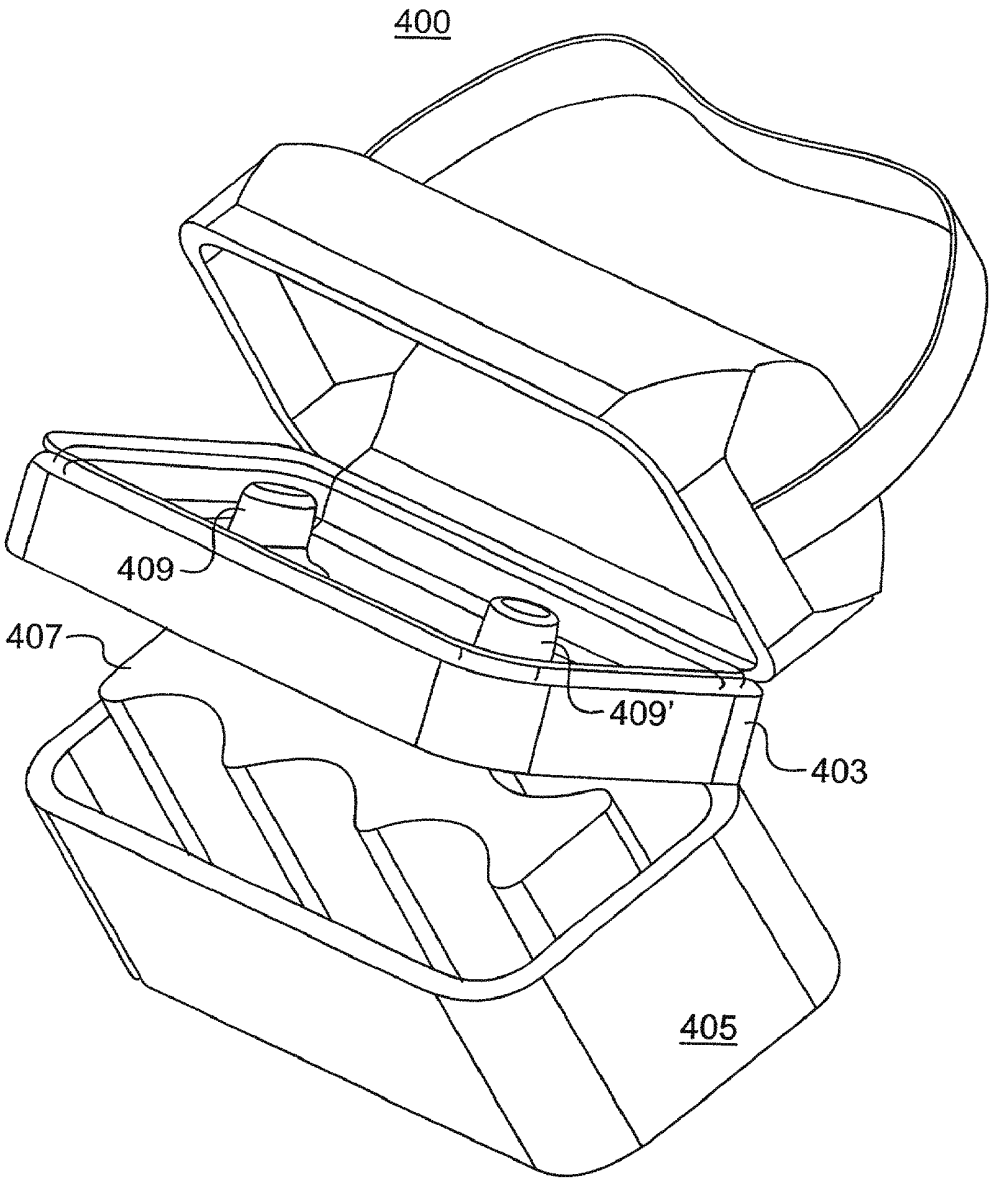


FIG. 26

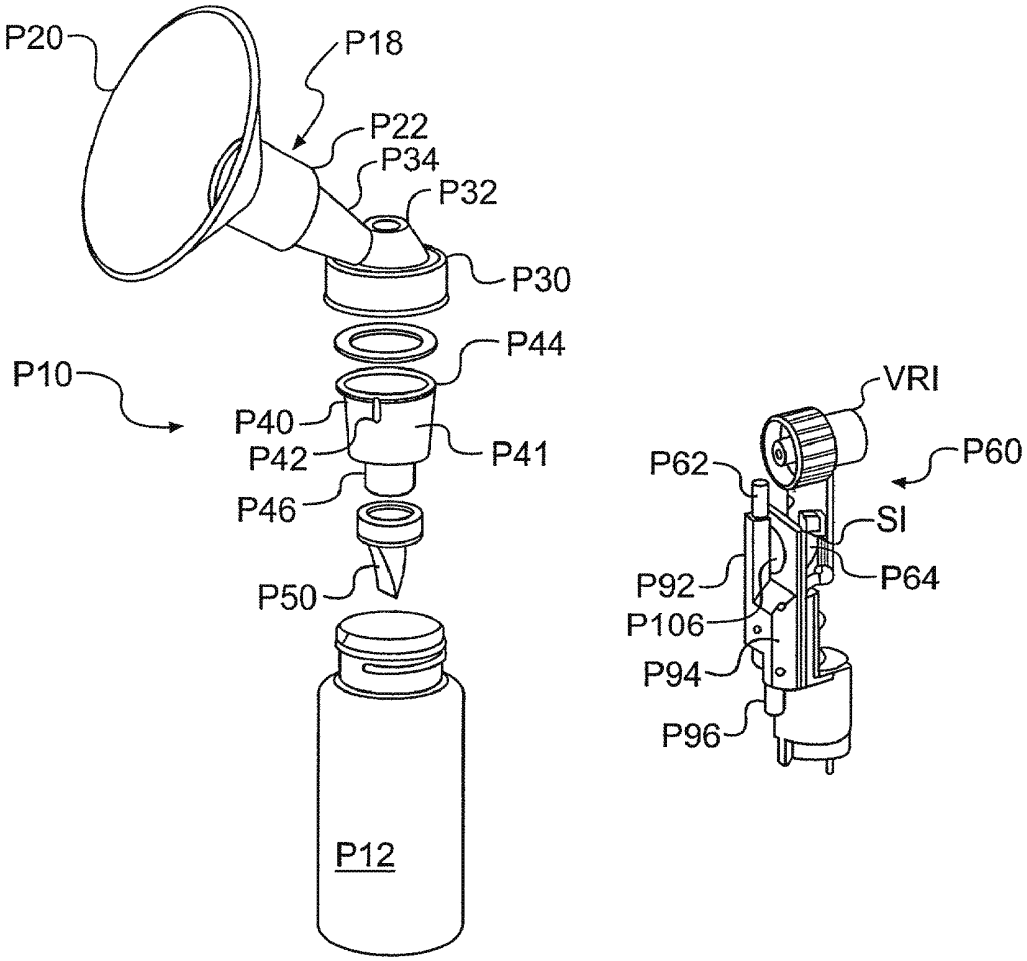


FIG. 27
PRIOR ART

SYSTEM FOR A PORTABLE HANDS-FREE BREAST PUMP AND METHOD OF USING THE SAME

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention generally relates to a portable, hands-free, and visually friendly breast pump system and method for collecting milk from a breast of a nursing mother which may be hidden from view when in use. In particular, the invention may be hidden underneath the clothing of a nursing mother, which provides privacy and avoids any attention and the awkwardness experienced by the nursing mother using existing breast pumps.

2. Description of the Related Art

Breastfeeding is the best source of nutrition for a baby, and it also offers health benefits to the nursing mother. Often, the nursing mother needs to use a breast pump to collect milk. A variety of breast pumps are available. The basic types of breast pumps include manual (hand operated) pumps and electric pumps. The electric pumps may be battery and/or AC powered. Further, the electric pumps may be self-cycling or require some manual user control. U.S. Pat. No. 6,213,840 combines a manual hand pump with a breast pump support bra which supports the weight of the breast. While most hand pumps are inexpensive and portable, they are typically uncomfortable, inefficient, and difficult to clean.

Some electric pumps are not battery-operated such that the nursing mother has to be near a power outlet. Other electric pumps, such as the diaphragm pump disclosed in U.S. Pat. Nos. 6,257,847 and 6,090,065, are assembled from many parts (hoses, gaskets, valves, etc.) which are difficult to clean, wash and carry. FIG. **27** illustrates such a prior art system from the '065 patent having many parts which makes it cumbersome and difficult to use. In particular, in such a traditional breast pump, the milk has to pass through a plurality of components, such as a funnel P**20**, a cylindrical guiding means P**22**, a cap assembly P**30**, a reservoir P**40**, an inlet P**62** connected to the suction assembly, etc., just to get to a container.

The website at http://www.epinions.com/kifm-Health-Nursing_and_Feeding-Breast_Pumps-All/tk_~PR001.1.5 lists many commercially available breast pumps. Most of the electric breast pumps, such as Hollister's Purely Yours™ Kit, are cumbersome and noisy, and thus very stressful for the nursing mother to use. In addition, while the nursing mother is using these breast pumps to collect milk, she cannot take care of the baby or do anything else.

Even more, these pumps share the disadvantage that the mother's breast is exposed during use (lack of privacy) and that their motors are noisy. The breast pump vest described in U.S. Pat. No. 5,571,084, although covering most of the breast, is heavy and inconvenient to wear.

Currently, there are no portable and user-friendly breast pumps capable of achieving private, quiet, easy, efficient, and effective breast-feeding.

SUMMARY OF THE INVENTION

It is a purpose of this invention to provide a portable and hands-free breast pump system that facilitates hands-free, private, quiet, easy, efficient, and effective breast-pumping.

It is another purpose of this invention to allow a nursing mother to collect milk via a breast pump hidden from view beneath clothing.

It is another purpose of this invention to allow a nursing mother to collect milk via a breast pump while nursing a baby or doing something else at the same time.

It is another purpose of this invention to provide a breast pump that has very few parts, and is easy to assemble and clean.

It is another purpose of this invention to provide a breast pump that is cost-effective and easy to transport.

It is another purpose of this invention to provide a breast pump with a vacuum chamber which also functions as a part of the vacuum mechanism.

It is still another purpose of this invention to reduce the contamination of the milk during the processing, such as collection and storage, by a breast pump system.

It is still another purpose of this invention to accurately emulate the suckling action of a baby when breast-feeding so as to facilitate the numerous benefits of breast-feeding to the mother and to the baby.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and additional features and characteristics of the present invention will become more apparent from the following detailed description considered with reference to the accompanying drawings in which like reference numerals designate like elements and wherein:

FIG. **1**A is a perspective view showing the front side of the breast pump according to a preferred embodiment of the invention; and FIG. **1**B is a perspective view showing the rear side of the breast pump according to the first embodiment of the invention.

FIG. **2** is a rear view of a top housing cover of the breast pump according to the first embodiment of the invention shown in FIG. **1**.

FIG. **3** is side view showing the breast pump according to a second embodiment of the invention.

FIG. **4** shows the details of the slide button according to the second embodiment of the invention.

FIG. **5** is an exploded view showing the breast pump of the first embodiment of the invention.

FIG. **6** is an exploded view showing the breast pump of the second embodiment in conjunction with a one-way valve and a splint.

FIG. **7** is an enlarged inset view of a positive connect pin of the breast pump according to the second embodiment of the present invention.

FIG. **8**A shows an adapter for connecting a positive contacting pin to an external power supply of the invention, while FIG. **8**B shows an example of a tethered drive configuration of the present invention.

FIG. **9** is an enlarged inset view showing the connection between the external power supply of FIG. **8**A and a positive contacting pin.

FIGS. **10**A and **10**B show cross-sectional views of different embodiments of the flange of the invention.

FIGS. **11**A-C show a rear-piston lever-arm system of the breast pump according to the second embodiment that communicates with the servomotor mechanism so as to move linearly.

FIG. **12** shows a second embodiment of a rear-piston lever-arm system in conjunction with a servomotor mechanism of the breast pump according to the first embodiment.

FIG. **13** show a third embodiment of the rear-piston lever-arm system in conjunction with another embodiment of the servomotor mechanism according to the invention.

FIG. **14** is an exploded view showing the servomotor mechanism illustrated in FIG. **13**.

FIG. **15** shows a second embodiment of the linear movement mechanism according to the present invention.

FIG. **16** shows a third embodiment of the linear movement mechanism according to the present invention.

FIG. **17** shows a one-way valve for use with the breast pump of the invention.

FIG. **18**A shows a splint for use with the breast pump of the invention, while FIG. **18**B shows an outer sleeve according to the present invention.

FIGS. **19**A and **19**B show a collection bag for use with the breast pump of the invention.

FIGS. **20**A and **20**B show cross-sectional views of the pump along with splint and the bag bent to conform with the contour of the user's breast and body.

FIGS. **21**A-C depict the actual suckling profiles of a seven-month-old baby boy.

FIGS. **22**A and **22**B depict the suckling profiles of the present invention.

FIG. **23** depict the suckling profiles of a conventional, mass-retail double pump set.

FIGS. **24**A and **24**B depict the suckling profiles of a conventional high-end double pump set.

FIGS. **25**A and **25**B depict the suckling profiles of a conventional battery powered portable pump.

FIG. **26** shows a carrying case for a breast pump system according to the present invention.

FIG. **27** is an exploded view showing the breast pump of the prior art (U.S. Pat. No. 6,090,065).

DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference to the figures, like reference characters will be used to indicate like elements throughout the several embodiments and views thereof. In particular, referring to FIGS. **1**A and **1**B, the breast pump **10** of the invention is embodied as a volume-displacement-type pump. FIG. **1**A is a perspective view of a preferred embodiment of the present invention showing the front side of the breast pump **10** with a dome-shaped housing shell **12**. The housing shell **12** gives a natural appearance of the shape of a breast when the pump **10** is concealed underneath the user's clothing. FIG. **1**B is a perspective view showing the rear side of the breast pump **10**.

The pumping action generated by the breast pump **10** depends upon a cycle rate and a vacuum level which are controlled via an adjusting means **14**. In one implementation, a user may use one finger to slide button **16** in an axial direction along the groove **18** so as to adjust the vacuum level (or range). FIG. **2** depicts the open top housing cover **12***a* of breast pump showing the rear side of the slide button **16** shown in FIG. **1**.

In a second embodiment shown in FIG. **3**, the slide button **16** is configured to slide in a circumferential direction along the groove **18** so as to adjust the pumping action to continuously vary the vacuum level. A push button **20** is used to control the cycling rate by incrementally increasing the rate with each push of the button **20** up to the fastest cycling rate designed into the pump. A further push of the button **20** then rolls the increment back to the slowest cycling rate for a continuous loop operation. FIG. **4** depicts that the slide button **16** is connected to an electrical contacting base **21** with an arm **16***a* so as to slide the electrical contacting base **21** and vary the vacuum level.

Referring to FIG. **5**, each breast pump **10** includes a housing shell **12**, a central deck **22** with a servomotor mechanism **24** integrated therewith, and a straw-hat shaped breast "flange" **30** having a flange top **35**. The servomotor mechanism **24** is a servomotor mechanism powered by at least one power source **26**, such as two AA batteries. The central deck **22** includes a pump seat **28** for receiving the servomotor mechanism **24**, two battery seats **32**, **32'** for receiving the batteries **26**, and a tunnel **34** extending toward the housing shell **12** for guiding and receiving a piston cylinder **25** of a rear-piston lever-arm system **100** (See FIGS. **11**A-**11**C). A central deck cover **22'** is used to fixedly encase the servomotor mechanism **24** and the two batteries **26** in the central deck **22**.

A second embodiment of the breast pump **10** as shown in FIG. **6** is designed for a breast larger than that to which the first embodiment shown in FIG. **5** is applied. Therefore, the central deck **22** of this second embodiment of the breast pump has a larger space that allows the two batteries **26** to be positioned parallel to one another. In addition, the central deck **22** of the second embodiment incorporates other parts for other parts, such as motor cover **40**, rather than the fewer integral pieces as in the first embodiment.

Specifically, the breast pump **10** of the second embodiment includes the housing shell **12**, the cycling rate button **20**, the vacuum level slide button **16**, the central deck **22**, the flange **30**, the servomotor mechanism **24**, and the batteries **26**. In addition, the second embodiment includes a flange support **36** placed between the flange top **35** and the piston cylinder **25**, a servomotor cover **40**, a battery cover **38**, a printed circuit assembly ("PCA")/microprocessor **90**, a PCA compartment **41**, a DC power jack pin **42** (positive), a DC power jack tab **43** (negative), a battery contact **52**, and a pair of screws **49** (FIG. **6**).

The first embodiment of the breast pump uses traditional positive and negative contact plates with springs for receiving each battery. In the second embodiment of the breast pump, one positive contact pin **42** (FIG. **7** inset view) is used instead. Both of these configurations would be known in the art for purposes of connecting to batteries held in small compartments.

The second embodiment of the breast pump (FIG. **6**) has an additional flange support **36** designed to protect against any overshooting of the strokes towards the flange top **35**. The flange support **36** is fixed in place with the control deck **22**, such as via a rotating lock mechanism, and then fitted around the exterior of the vacuum chamber **60** so as to have an interference fit at least around the base of the flange **30** (i.e., the 'bellows' area of the flange which creates the air displacement). The flange support **36** is an individual part of the unit assembly designed to be attached onto the flange **30**. The flange support **36** not only holds the flange **30** in place during the pumping action (prevents over-pressure on the flange top **35**) but also supports the vacuum chamber **60** from collapsing.

Unlike most other breast pumps which have their pump mechanisms situated outside of their breast interface elements or even at a remote distance from the breast interface element, the servomotor mechanism **24** of the invention is integrated inside the pump **10**. The servomotor mechanism **24** is designed to be lightweight (for example, 0.4 oz. making each entire pump **10** weigh only 2.4 oz. without batteries or 4.2 oz. with batteries) such that it sits directly inside the pump **10** and is supported by the housing without any additional components. As shown in FIG. **20**B, the pump **10** is held in place between the woman's breast **13** and the breast cup **11** of her bra with the pump's dome-shaped housing **12** facing the bra breast cup **11** and the flange **30** facing her breast **13**. When placed in this position, the pump **10** is exclusively supported by the bra and the negative

pressure created between the breast and the flange **30** by the servomotor mechanism **24** and the lever arm system **100**. In variations of the present invention, the servomotor mechanism **24** may be substituted with an external driving mechanism, such as an electrical motor or a tethered manual pumping device, to provide the negative pressure for pumping. The implementations of such substitute devices would have those devices modularized such that they could be substituted for one another and be easy to replace.

In a third embodiment of the breast pump, power for the external servomotor mechanism **24** is located outside the housing. As shown in FIG. **8**A, an adapter **46** is used to connect a positive contacting pin to the external power supply **26** via a wire **26***a*. FIG. **9** shows an inset view of how the adapter **46** is attached to the positive contacting pin **44**. This embodiment has the advantage of a longer-lasting power supply that can be used, for example, in an institutional setting (i.e., a hospital) or even a home setting where a more limited range of mobility is acceptable or even desired.

Alternatively, as shown in FIG. **8**B, the servomotor mechanism **24** may be replaced by a servomechanism **24'** that may be just a mechanical or pneumatic linkage **101** connected to the lever arm **21** for implementing the pumping action of the vacuum chamber **60**. The linkage **101** is connected to a remote control **103** that acts as the user's control for pumping via a linkage element **103**. For example, in a mechanical implementation, the linkage element **103** is a wire in a sleeve similar to that used in bicycle handbrake controls, while the control **103** is a hand- or foot-pedal that the user manipulates to move the lever arm **21** in the pump **10**. Alternatively, in a pneumatic implementation, the linkage element **103** is a flexible pipe that feeds air or fluid into the linkage **101**. The control **102** is also a hand- or foot-pedal that controls the flow of control air/fluid to the linkage **101** to then operate the pumping motion of the lever arm **21**. The specific details for implementing either of the above-discussed alternative embodiments would be within the knowledge of those skilled in the art.

Various components of the system are formed from resiliently plastic or other resin-type materials to accomplish various purposes. For example, in order that the splint **110** be flexible so as to conform with the shape of the user's breast, and so that the overall structure of the pump **10** is lightweight, including but not limited to the housing shell **12**, the housing cover **12***a*, the lever arm **21** and the central deck **22**, these various parts are formed from plastic. Other components in the system would be formed from materials appropriate to their function as would be understood by those skilled in the art. Other materials for the various components may also be used as would be known in the art so long as the selection of such materials is not inconsistent with the structure, operation and purpose of each such component and of the present invention as a whole.

In the general operation and use of the present invention, as shown in FIG. **20**B, the pump **10** contacts the breast only with the breast flange **30**, and the dome-shaped housing shell **12** does not contact the breast. A vacuum chamber **60** is defined between the breast flange **30** and the breast, and is completely isolated from the working components of the breast pump **10**; the servomotor mechanism **24** is only in contact with the exterior surface of the breast flange **30**. This allows the vacuum chamber **60** to be maintained at a negative air pressure while keeping the breast milk from contacting any other parts of the breast pump **10**. The invention significantly reduces the number of parts that can come in contact with the milk so as to make the system easy to clean and sanitary. Further, the invention eliminates the potential of the milk co-mingling with any room air contaminants.

The breast flange **30** is made from silicone or other soft elastic material for interfacing directly with a breast and situated on the breast with an inlet hole **50** (See FIGS. **5**, **10**A and **10**B). The inlet hole **50** is designed for seating a nipple and areola in a vacuum chamber **60** which is defined between the breast pump **10** and the breast. The soft breast flange **30** allows the wearer to pump milk quickly and painlessly by mimicking the baby's suckling movements when the servomotor mechanism **24** moves the flange **30**, thereby triggering the female body's natural reaction to produce milk.

A health benefit for the user or mother derived from the invention is that, as the nerves in the nipple and areola are stimulated by the action of the invention, the pituitary gland receives a signal to release prolactin and oxytocin into mother's blood stream. Prolactin relaxes the mother and stimulates the alveoli to produce more milk. Oxytocin causes the alveoli to contract and squeezes milk into the ducts. In contrast, the traditional hard funnel breast pumps (See FIG. **27**) simply pull the nipple into the rigid shaft to obtain milk. The hard shaft of the funnel is rigid and unyielding so that the suction concentrates on the nipple and creates a stinging sensation.

Varying thicknesses in the silicone flange **30** helps the breast pump **10** to attach to the breast and be compressed towards the nipple by the rear-piston lever-arm system **100** shown in FIGS. **6**, **11**A-**11**C and **13**. Pumping sessions become faster by using the soft flange **30** since the milk is being removed in a more natural way than with a traditional hard funnel. As such, the milk is also better extracted from the breast to avoid any decrease of milk production due to the remaining breast milk in the breast. The milk residuals reduce hormone stimulation for milking.

As shown in FIG. **10**A, the flange **30** includes an outlet **62** through which the milk drawn from the breast flows out of the flange **30**. As will be discussed further herein, the milk is then directed away from the breast pump **10** and stored. In a variation of the flange **30**, as shown in FIG. **10**B, the outlet **62** is funnel-shaped so as to direct the milk flow out of the flange **30** and prevent the milk from flowing back towards the breast.

In at least one of the embodiments of the invention, the nipple is well seated at the back of the breast pump **10** (inside the chamber **60**), where only air is directly in contact with the nipple. When the nipple is placed inside the flange **30**, the nipple rests within the vacuum chamber **60** with the surface of the surrounding area of the breast in contact with the surface of the flange **30**. Air compression and suction is then controllably generated to occur by virtue of the cap-shaped piston cylinder **25** being cyclically pushed toward the breast so as to physically push on the top **35** of the flange **30** (see FIG. **11**A), and then released. The top **35** is formed with a relatively thin and soft side wall which has an accordion-style, contour-shape with alternating convex and concave edges formed on its surface for transferring and converting the contact pressure from the cap-shaped piston cylinder **25** to air compression and suction on the nipple. In order to strengthen the top **35** and to help in uniformly compressing the vacuum chamber **60**, the top **35** may be formed with a circular, reinforcing plate **35***a* fixedly imbedded therein. The reinforcing plate **35***a* is formed with a dome-shaped alignment stub or nipple **35***b* on a top center portion of the plate that aligns with the alignment dome **25***b* of the piston cylinder **25** so as to center the vacuum chamber

60 within the piston cylinder 25. This centered alignment is especially important in keeping the vacuum chamber 60 from floating or misaligning within the piston cylinder 25 during the pumping operation.

In a first embodiment of the rear-piston lever-arm system 100, as shown in the exploded view of FIG. 11A, the top of the piston cylinder 25 is shaped like a yo-yo or a doughnut without a hole. The lever arm 21 has a protrusion 21*a* on the top that contacts with the alignment dome 25*b* of the piston cylinder 25. The lever arm 21 is a projecting handle used to adjust or operate the piston cylinder 25. In particular, the-rear piston lever-arm system 100 mechanically communicates with the servomotor mechanism 24 so as to be activated by the mechanism and thereby pivotally move the lever arm 21 which then linearly moves the piston cylinder 25 along a line generally parallel with the centerline of the pump 10. Such a linear movement is depicted, wherein the start or "upstroke" position of the piston cylinder's linear movement is shown in FIG. 11B.

FIG. 11C shows the lever arm 21 pivoted forward thereby linearly pushing the piston cylinder toward the flange 30 in a "downstroke" motion. The lever arm 21 pushes the protrusion 21*a* against the alignment dome 25*b* of the piston cylinder 25 to move the piston cylinder 25 toward the nipple. As mentioned, the nipple is insulated by the vacuum chamber 60 of the flange 30 from direct contact with other components such as the piston cylinder 25. The motion of the piston cylinder 25 is controlled by the level arm 21 which sets the default position of the piston cylinder 25 within the tunnel 34 such that the piston cylinder 25 rests away from the breast when the pump is not in action. During operation, in the "upstroke" motion, the lever arm 21 pivots back thereby releasing the piston cylinder 25 and the top 35 of the flange 30. The movement of the piston cylinder 25 is rather short, delicate and efficient in comparison with the pumping action of other breast pumps.

The servomotor mechanism 24 activates the rear-piston lever-arm system 100 embodied in the lever arm 21 and the piston cylinder 25 to create the "downstroke" action inward (toward the breast). This downstroke action displaces the air in the flange 30 which exits via a one-way valve 140 (See FIG. 17) that is inserted into the outlet 62, thereby releasing the vacuum and actively stimulating the breast for further expression of milk. In addition, milk expressed by the breast flows out also through the one-way valve 140 and into a collection bag 300 (as will be explained further herein). The "upstroke" action not only moves the lever arm 21 and the piston cylinder 25 back into their start positions, but also generates the vacuum pressure against the breast. The upstroke and downstroke action of the system 100 alternatingly generates and releases the volume displacement vacuum in the chamber 60, and in particular in the flange 30. Among the features of this construction, the "upstroke" passively maintains or creates the vacuum via the vacuum chamber 60 of the flange 30 elastically returning to its normal state, and not by any energy expended by the servomotor mechanism 24. However, in other embodiments, the protrusion 21*a* may be linked to piston cylinder 25 and the top 35 so as to actively generate both the "upstroke" and "downstroke" motions of the vacuum chamber 60.

In order to further simulate the suckling motion of an infant, the preferred suckling time to releasing time is, for example, approximately 3:1 in a cycle of a second. Namely, the suckling stage takes ¾ second, and the releasing stage takes ¼ second for each cycle. However, other cycling ratios may be used based on individual user preferences or breast-feeding requirements. The combination of the servomotor mechanism 24, the lever arm 21 and the piston cylinder 25 provides precision control of the air compression inside the chamber 60 which allows the precise controlling of the cycle rate and the vacuum level.

In a second embodiment of the rear-piston lever-arm system 100, as shown in FIG. 12, the lever arm 21 is formed to surround the side wall of the cylinder piston 25 and connect to the piston via a protrusion 25*c* formed on the side wall. When the lever arm 21 pivots, it rotatively pushes on the protrusion 25*c* (rather than push on the top 35 of the piston cylinder 25) thereby linearly moving the cylinder piston 25. Otherwise, the operation and effects of this second embodiment are the same as those of the first embodiment.

As shown throughout the drawings, the present invention includes various embodiments for the servomotor mechanism 24. FIGS. 11A-C depict using a first embodiment of servomotor mechanism 24, while FIGS. 5 and 12 illustrate a second embodiment of the servomotor mechanism 24 that is used with the rear piston 25 and the modified lever arm 21. FIGS. 6 and 13 shows a third (preferred) embodiment of the servomotor mechanism 24 applied to a third variation of the lever arm 21.

FIG. 14 illustrates an exploded view of the third embodiment of the servomotor mechanism 24 so as to provide an example of the internal structure for a servomotor mechanism that would be applicable to the present invention. That embodiment is implemented via a structure that includes a potentiometer 201, an output gear 202, cluster gears 203-206, a DC motor 207, an arm 208, a motor housing 209, a screw 210, a rotary pot contact 211, a power contact 212, a gear train motor shaft 213, a front cover 214, a rear cover 215, and a pinion gear 216. Essentially, a servomotor mechanism for the present invention is implemented via mechanical or electromechanical system that pivotally moves a lever arm that then linearly moves a piston (in this case, a cylindrical piston 25) that then creates the pumping motion in the flange 30. The electric motor structure of the third embodiment (even of the first and second embodiments) as described above is one such system. Otherwise, given this disclosure of the invention, one of skill in the art should be able to devise other structures for a servomotor mechanism that would serve the purposes of the present invention and within the scope and intent of the claims.

FIGS. 15 and 16 illustrate other systems for providing the above-mentioned linear movements for the cylindrical piston 25, and thus the pumping operation of the flange 30. For example, FIG. 15 shows a lead screw mechanism with a rotary motor. The motor 240 oscillates at a cycle rate set by the user, and the vacuum level is controlled either by the user also, or by a microprocessor 90 (See FIG. 6) according to a predetermined stroke/suckling profile. The rotation of a lead screw 250 pushes a plunger 260 so as to push the top 35 of the flange 30 toward the breast. The reverse rotation of the motor 240 rotates the lead screw 250 away from the breast so as to move the plunger 260 away from the breast. This allows the flange 30 to return to its natural state so as to create a negative pressure in the vacuum chamber 60.

In FIG. 16, the lead screw 250 is substituted with a rack and pinion 270, wherein the motor 240 again oscillates at a cycle rate set by the user, and the vacuum level is controlled either by the user also, or by a microprocessor 90 (See FIG. 6) according to a predetermined stroke/suckling profile. The linear movement of the rack and pinion 270 pushes the plunger 260 pushing the top 35 of the flange 30 toward the breast. The reverse rotation of the motor 240 linearly moves the rack and pinion 270 away from the breast so as to move the plunger 260 away from the breast. Again, this allows the

flange **30** to return to its natural state and create a negative pressure in the vacuum chamber **60**.

The one-way valve **140** shown in FIG. **17** is used in conjunction with the outlet **62** of the flange **30**. The valve is generally implemented as a one-piece element that is inserted into the outlet **62**. Alternatively, the one-way valve may be constructed as an integral part of the flange **30**. Its main function is to help maintain the vacuum in the chamber **60** during operation and to help draw the expressed milk away from the chamber **60** in the flange **30** so as to flow to a collection bag **300**. However, other embodiments as those of skill in the art would understand may be accomplished used to implement the one-way valve **140**.

The splint **110** shown in FIG. **18**A guides the milk from the pump to a collection bag **300**. The splint **110** has a cup **115** and a wave-form portion **117**. The cup **115** and the wave-form portion **117** of the splint **110** are inserted into the neck of the collection bag **300**, extending downward to ensure the neck walls do not collapse due to the pressure from the bra at the point where the collection bag exits at the bottom edge of the bra (as will be discussed further hereinbelow). The cup **115** is formed to pressure fit into the outlet **70** of the housing shell **12** when inserted using an upward sliding force. The cup **115** is intended to have at least a liquid-tight fit within the outlet **70** while guiding the milk out of in the chamber **60**. Preferably, the cup **115** has an air-tight fit when positioned in the outlet **70**. Such a pressure fit is intended to hold the bag **300** tightly to the cup **115** so as to avoid any milk spillage and any air contaminants therebetween. At the bottom of the cup **115**, there are holes **116** through which the milk is intended to flow out of the cup **115** and onto the wave-form portion **117** of the splint **110**. In a preferred embodiment, the cup **115** has an extruded rim which will contact the outer edge of the neck of a collection bag **300** so as to further seal the neck. The splint may be formed integrally with the bag by incorporating the extruded tube in the construction of the collection bags. In such a case, a hot-pressed tear-off line is set between the end of the splint and the end of the bag neck.

Also, in another variation as shown in FIG. **18**B, an outer sleeve **111** is used to surround the neck **310** of the bag **300**. The outer sleeve serves to protect the neck of the bag **300** as it extends from the pump to the body **305** of the bag **300**. In this implementation, the neck **310** of the bag connects directly to the one-way valve **140** with the sleeve **111** surrounding the connection. In one form, the outer sleeve **111** is C-shaped in cross-section and also formed of a resiliently plastic material, which allows the sleeve to have some flexibility. Other cross-sectional shapes or configurations as would be understood by one of skill in the art to perform the same function as the C-shaped sleeve may be used.

When viewed along its longitudinal axis, the wave-form portion **117** has a substantially sinusoidal contour, wherein the peaks and valleys of the sinusoidal contour form channels along which the milk flows downward to the collection bag **300**. The use of the wave form portion **117** enjoys several benefits over using a conventional tube form. First, it avoids any obstruction caused by air bubbles stuck in a tube. Second, a splint having a wave-form portion is more easily bent than a tube so as to conform with the contour of the breast and the bra to in order to reach the collection bag or a bottle. Third, the wave-form portion is easier to clean and keep sanitized than a tube. Plastic tubing needs to be cleaned each use. If washed, it has to be hung to allow it to drain and dry thoroughly. In contrast, the wave-form splint dries out more easily than a tube form. Lastly, a wave-form structure confronts less air resistance than a tube when it is inserted into either a regular container or the collection bag **300**. As will be discussed further hereinbelow, the sub-assembly of the one-way valve **140** and the splint **110** provides further support for the vacuum chamber **60** so as to prevent it from collapsing.

As shown in FIGS. **19**A and **19**B, the collection bag **300** is made of plastic and substantially deflated so as to be maintained in a substantially vacuum state for receiving the splint **110** and the milk. In one embodiment, the collection bag **300** is made by hot-pressing two thin plastic sheets to form a square bag body **305** with sealed edges **301**, **301'**, **302**, **303**, **303'** and a neck **310** with sealed edges **311** and **311'**. Meanwhile, each perforation line **312** is punched with holes for easily separating the bags with a slight force. At the same time, graduations are printed on the surface of one plastic sheet to indicate ounces or milliliters. The sequentially hot-pressed bags are rolled into one roll to reduce storage space and make them easy to transport. Alternatively, the bags may be made using other conventional methods for fabricating plastic bags known in the art. Also, the bags may be formed into other shapes or with additional features (i.e., resealable tops, adhesive surfaces) or using other different materials that have the same manufacturing, sanitary and liquid-proof characteristics.

The sealed edges **311** and **311'** of the neck extend into the bag body **305** so that the splint **110**, including the cup **115**, can be fully inserted inside the neck **310** to completely seal the splint inside the collection bag **300** thereby avoiding any milk spillage outside of the collection bag **300** during use. After the collection bag **300** is filled, a user can remove the splint **110** and roll the neck **310** so as to seal the bag. Further, adhesive tape or an adhesive surface formed on the neck **310** or the body **305** may be used to fixedly secure the rolled neck to the body of the bag.

In another embodiment, an additional pair of sealed edges **306**, **306'** in a V-shape are hot-pressed next to the neck **310** to provide additional pressure on the neck after the neck has been pressed from the top-down to expel any residual milk in the neck of the bag. In addition, the sealed edges **311**, **311'** include lower extensions that promote the sealing of the neck **310** when the neck is pressed, so as to function as a simple, one-way valve to prevent milk spillage after the neck is press-sealed. The neck of the collection bag with the sealed edges in a V-shape effectively becomes spill-proof after being pressed shut. This structure of the bag **300** solves the common problem encountered by mothers that use conventional plastic collection bags when they pump for breast milk. The plastic collection bags of the prior art have not been able to provide any effective means for sealing closed so as to allow the mother to put down the bags without spilling.

In a further embodiment of the invention, an additional tear notch **304** is hot-pressed at a corner of the bag so that a user may tear off the bag at the line to release the milk into another container to feed a baby. Additional tear notches are hot-pressed at the neck of the bag so that a user may alter the length of the neck by tearing off the bag at any one of the notches.

In a preferred implementation, each bag **300** is a freezer grade bag made of FDA rated plastic and intended only for single use so as to keep the milk from contamination caused by any residuals of old milk and eliminate laborious cleaning. The preferred dimensions of the bag body are 4.25 inches by 3 inches, and the dimension of the neck is 5.0 inches in length. The capacity of each bag is 4-8 ounces, which is the average production amount for a nursing

mother. However, other dimensions may be used as one of skill in the art would understand.

Like breastfeeding, pumping is a learned skill. Most mothers are able to express only a few drops of milk when they first try a breast pump. Sometimes if mothers don't see milk immediately after beginning pumping, they start to pump harder or increase the suction with the mistaken idea that more pressure will "pull" the milk out. Doing this can cause discomfort and anxiety and actually discourage the let-down response. The invention is simple and easy to use so that the mother will intuitively become efficient at pumping without much practice and knowledge of how the breast works. In addition, many working mothers have no option but to pump in their offices or in a restroom. The privacy of using a conventional breast pump and the effect of the ambient air on the safety of the breast milk are at issue.

As generally illustrated in FIGS. **20**A and **20**B, a user just inserts a one-way valve **140** (if made as a separate component) into the hole in the flange **30** as a cap on the splint/bag. Otherwise, if the valve **140** is manufactured to be an integral part of the flange **30**, then the user just then proceeds with inserting the "splint" **110** (the wave-shape guiding means) into neck **310** of a disposable collection bag **300**. The splint **110** serves to keep the neck **310** of the bag fluid-passable as it passes underneath the bottom edge of the bra. The sub-assembly is inserted into the outlet **70** of the housing **12** at the bottom of the flange **30** and the breast pump **10**. With the sub-assembly in place, the cup **115** of the splint **110** fixedly connects to the outlet of the one-way valve **140**.

There is no need for the mother to undress herself in order to use the breast pump of the invention. In contrast, all the prior art requires a user to undress herself so as to use the pump.

After inserting the splint **110** into the housing shell **12**, the user can insert the entire pump **10** with the sub-assembly of the splint **110** and collection bag **300** underneath her clothing and against the her breast. The inlet hole **50** is positioned over the breast so as to cover and surround the nipple and thereby catch the expressed breast milk. Alternatively, the user can insert the pump **10** underneath the clothing first, then insert the sub-assembly of the splint **110** and the collection bag **300**.

In at least one embodiment, the insertion of the sub-assembly may be designed to act as an activation switch for the operation of the pump **10**. Alternatively, either the slide button **16** or the push button **20** may be used as the activation switch, or a combination of the slide button **16** or the push button **20** in conjunction with the insertion of the sub-assembly. In an even further embodiment, the servomotor mechanism **24** may be activated by an initial movement of the switch **16** resulting from the insertion of the sub-assembly.

When a collection bag is filled or when the user is finished using the pump **10**, the splint **110** along with the bag **300** is removed from the pump **10**, but with the one-way valve **140** left in place to keep the outlet **70** plugged thereby prevent any milk from dripping out of the outlet **70**. Upon removal of the sub-assembly, in one embodiment, contact between the sub-assembly and a switch of the servomotor mechanism **24** is severed which turns off the pump **10**. As mentioned, the vacuum chamber **60** is air-tight and isolated from outside air turbulence. Such a design not only maintains the privacy of the user but keeps the pump from contacting any outside air contaminants.

With respect to the adjusting means **14** (See FIGS. **1**A, **1**B and **3**), the pumping rate is controlled via a microprocessor **90** which reads the user inputs from the switch slide button **16** and the push button **20** for the vacuum level and the cycling rate, respectively, so as to power the servomotor mechanism **24** accordingly. The servomotor mechanism **24** in turn activates the rear-piston lever-arm system **100** to create a stroke action toward and away from the breast in accordance with the desired settings. When the appropriate time has passed, the microprocessor **90** will reverse the motor system to allow the flange **30** to return to its natural state. As noted above, the stroke action is programmed to mimic the natural suck-hold-release-relax cycling of a nursing baby according to the age of the baby. The present invention applies mimicking the baby's suckling movements to trigger a nursing mother's natural reaction to produce milk. The pumping rate in the present invention may be controlled and/or programmed to mimic both the nutritive and non-nutritive suckling actions of the a baby, which have distinctly different cycling characteristics.

According to a controlled study of a seven-month-old baby boy, the suck-hold-release-relax cycle starts with a series of non-nutritive sucks at low vacuum levels with a high suckling rate as the suckling pulses depicted in FIG. **21**A. The non-nutritive suckling rate typically is higher than nutritive suckling; in this example, the non-nutritive suckling exceeded 100 cycles/min while nutritive suckling was 30-60 cycles/min. The peak vacuum level of each suck increases until reaching a threshold for milk expression (the first and second nutritive sucks) then holds longer on the threshold (152 mmHg, in this case) than non-nutritive sucks with no plateau but mere a peak. The plateaus exhibit distinct flatness to hold the threshold vacuum level of each cycle. The holding period (in the plateau) is about 2-3 times of the relax period (drop from the plateau).

FIG. **21**B shows a second example illustrating a steady-state post-ejection reflex action. Essentially, the baby has achieved a rhythm in suckling. FIG. **21**C illustrates the threshold vacuum level decreasing with the cycle rate increasing. In this example, the baby is finishing feeding and/or tiring. Overall, the study reveals that the holding and releasing timing of a baby suckling is not symmetrical. Depending on the baby, there may be rapid transitions between holding and releasing periods. In the present invention, the microprocessor **90** is programmed to mimic the natural suck-hold-release-relax cycling of a nursing baby along the lines of the results of the study.

The microprocessor **90** may be programmed to suggest or control the vacuum level and the cycle rate. In one preferred embodiment, the microprocessor **90** is programmed with artificial intelligence so as to mimic the natural suck-hold-release-relax cycling of a nursing baby as discussed. Each stroke of the breast pump of the present invention has a definite holding period, which is about 2-3 times the relaxation period. As depicted in FIGS. **22**A and **22**B, the cycle profile is designed to be consistent regardless of the maximum vacuum level or the cycle rate settings.

In particular, the suction level starts at a minimum at the beginning for a new nursing mother, and then some quick, short pulses at the start of the pumping to especially stimulate and imitate more closely the way a baby initiates breastfeeding. Once the milk is flowing freely, long steadier strokes are initiated so as to be effective and less tiring. Since each woman has a different comfort level, the level may then be gradually increased to what is comfortable for her. The pumping mechanism supports a cycle rate up to 80 cycles per minute, which is higher than most of the other portable breast pumps (25-60 cycles/minute). However, the preferred cycle rates range from 35-60 cycles per minute which balances the efficiency and the comfort of the user. The most

preferred cycle rate (45 cycles/minute) takes less than one-quarter second to fully vacuum the chamber **60** and incurs minimum noise.

This stroke action creates a vacuum on the order of 200 mmHg in the flange **30** while the one-way valve **140** seals off the opening. As shown in FIGS. **22**A and **22**B, when the maximum vacuum level is set at 136 mmHg, the matching cycle rate is 39 cycles/min. when the maximum vacuum level is set at 204 mmHg, the matching cycle rate is 36 cycles/min. Vacuum control circuitry is provided for allowing manual adjustment of the level of vacuum generated by the electric pump means. This is accomplished by controlling the stroke length of the servomotor mechanism. In another embodiment of the invention, some residual vacuum is programmed in the stroke profile.

In another variation of the invention, a flow sensor may be connected with the adjusting means **14** to monitor the suckling results of the stroke actions.

In contrast, the commercially available products simply operate under mathematics profiles rather than a natural baby suckling profile as the present invention. For example, the characteristics of one inexpensive, mass-produced double pump set allows manual control as well as residual vacuum as shown in FIG. **23**. However, it operates with excessive tissue stress due to its slow vacuum rise profile. In addition, it operates terribly inefficient at 7 cycles/minute, which takes 8 seconds to reach the full vacuum level of 220 mmHg. Other conventional high-end double pump sets operate according to the profiles such as those shown in FIGS. **24**A and **24**B which are within appropriate vacuum levels (180-200 mmHg) at an appropriate cycle rate range of 47-53 cycles/min. Nevertheless, such systems have no holding periods, but instead release their vacuums immediately upon reaching full vacuum. One popular battery powered portable pump as shown in FIGS. **25**A and **25**B operates with appropriate holding periods (1-1.4 seconds) and releasing periods (0.9 second), but dragging along a slowly increasing profile from vacuum levels 100 to 270 mmHg at inefficient cycle rate range of 27-29 cycles/min. Such a profile yields long periods of stress on the breast to reach a excessively high vacuum level of 270 mmg.

Studies and experience have shown that young breastfed babies usually need to nurse every 2-3 hours, and that it is best to pump on the same schedule. The more the breasts are stimulated, the more milk is produced. A good time for many mothers to pump is about one hour after the baby's first morning feeding. Most women tend to have more milk earlier in the day. The length of time spent pumping varies with each woman and with each day. When pumping one side at a time, alternating breasts several times during expression is more stimulating and can result in a higher volume of milk. Pumping at one side of the breast and nursing on the other side has the advantage of using the body's natural response to let down the milk for the baby.

The microprocessor **90** of the present invention may be programmed to suggest or control the timing for pumping. For example, using two pumps **10** simultaneously can cut the total pumping time in half. Double pumping may also result in better stimulation of prolactin due to its sense of balance provided to a nursing mother. In a double pump arrangement, the adjusting mechanism **14** of each pump may be linked by hardwire connection or by wireless link to coordinate or synchronize their strokes via the microprocessor **90**.

A commercial implementation of the portable breast pump system of the invention as shown would include two breast pumps **10**, a pair of valves **140** and splints **110**, and a roll of collection bags. All of those components would be stored in a soft sided black shoulder bag **400** (FIG. **26**) having two storage compartments, the upper compartment **403** includes a working surface for storage of the pumps on its breast pump holders **409**, **409'**, the accessories, and complete instructions; and the lower compartment **405** includes heat-insulating side walls and at least one cooling element **407**. The cooling element **407** is formed with concave seats for receiving collection bottles or bags. The closeness of the walls hold the collection bags next to the cooling element surfaces. The portable breast pump system of the invention would weigh only about 2 lbs., rather than the 8-10 lbs. of other commercially available portable breast pump system, or even then 25-40 lbs. of those used in hospitals. The cooler is available from Rubbermaid® (Blue ICE Model No. 1056). The shoulder bag **400** may be manufactured by companies such as California Innovation® with synthetic fabric surfaces which are easy to wipe clean. The aggregate weight of the cooler and the shoulder bag is approximately 2.5 lbs.

Parts of the pump such as the collection bags **300** are sterilized to FDA's hygienic standard for rubber articles before the first use, while other parts that come into contact with the mother's skin or the milk will need to be sterilized before first use. After initial use, only the flange **30**, the valve **140** and the splint **110** need to be washed in warm, soapy water, rinsed with hot water and drained on a clean towel. However, periodic boiling for sterilization may be desirable, depending on the individual needs of the baby.

In summary, the breast pump of the present invention provides several unique features. As noted above, various parts of the system are made of plastic materials so as to be lightweight, easy to clean/maintain and easily conform with the contour of the user's breast (FIGS. **20**A and **20**B). Working moms can thus easily pump their milk and save it for the babysitter or daycare. The breast pump of the invention has very few parts so as to be easily assembled and cleaned. The overall system of the present invention also results in a breast pump smaller than commercially available breast pumps such as Hollister's Purely Yours™ Kit, i.e. about ¼ size of other portable (the shoulder bag actually is 70% smaller) and Medela's Pump in Style system.

The principles, preferred embodiments and modes of operation of the present invention have been described in the foregoing specification. However, the invention which is intended to be protected is not limited to the particular embodiments disclosed. The embodiments described herein are illustrative rather than restrictive. Variations and changes may be made by others, and equivalents employed, without departing from the spirit of the present invention. Accordingly, it is expressly intended that all such variations, changes and equivalents which fall within the spirit and scope of the present invention as defined in the claims, be embraced thereby.

What is claimed is:

1. A breast pump comprising:

a housing having a generally dome-shaped side and carrying a self-contained power source and a pump mechanism;

a breast interface flange supported by the housing;

an outlet for expelling breast milk received from a breast interfaced with the flange; and

the housing and flange being sized and configured to be supported between an adult human breast and a breast cup of a bra, with the generally dome-shaped side of the housing facing the breast cup of the bra and the breast interface flange facing the adult human breast, while

the breast pump is actively pumping milk from the breast and expelling the milk through the outlet.

2. The breast pump of claim **1**, wherein:

the housing and flange are sized and configured to be worn under typical upper body clothing worn in a normal wearing mode, with the bra supporting the housing and flange without the aid of hands or body-worn supporting devices other than the bra, while the breast pump is actively pumping milk from the breast and expelling the milk through the outlet;

whereby a wearer of the breast pump and clothing may ambulate with the breast pump operative and untethered to external fixtures.

3. The breast pump of claim **1**, further comprising a one-way valve coupled to the outlet and operable for:

allowing milk to pass through the outlet when the flange is compressed by the pump mechanism to create positive pressure within the flange;

sealing the flange to allow a reversal of the compression of the flange to create negative pressure within the flange; and

whereby the negative pressure creates a milking action for causing milk to be expressed by the breast.

4. The breast pump of claim **3**, further comprising:

a splint defining a coupling end, a milk delivery end, and an elongate, narrow conduit between the coupling end and the milk delivery end;

the coupling end in fluid communication with the outlet;

the milk delivery end in fluid communication with a collection bag; and

the splint and collection bag being sized and configured to be supported by the bra while the breast pump is actively pumping milk from the breast, through the outlet, along the splint, and into the collection bag.

5. The breast pump of claim **4**, wherein:

the narrow conduit of the splint defines a wave shape across its narrow dimension;

the bag comprises an elongate neck configured for receipt around the conduit; and

whereby the conduit conveys milk from the outlet into the bag while the bag neck and splint conduit are captured and supported between a lower edge of the bra and the wearer's body, without the aid of hands or other body-worn supporting devices other than the bra, while the breast pump is actively pumping milk from the breast and expelling the milk through the outlet.

6. The breast pump of claim **1**, further comprising a controller configured to drive the pumping mechanism to mimic a feeding cycle representative of a human nursing baby.

7. The breast pump of claim **6**, wherein the feeding cycle comprises:

a non-nutritive suckling phase of the cycle defined by a relatively low vacuum, a relatively high suckling rate, a relative absence of extended holding plateaus, and a relative absence of extended release periods;

a nutritive suckling phase following the non-nutritive suckling phase defined by a relatively high vacuum, a relatively low suckling rate, a relative presence of extended holding plateaus, and a relative presence of extended release periods; and

the transition between the non-nutritive suckling phase and the nutritive suckling phase timed to coincide with an expected onset of milk letdown from the breast.

8. The breast pump of claim **7**, wherein the nutritive suckling phase further comprises a steady-state portion that is at least three times longer than the non-nutritive suckling phase, and during which the lengths of the holding plateaus are at least two times the length of the release periods.

9. The breast pump of claim **7**, further comprising a user-accessible control device for adjusting the vacuum level produced by the breast pump during the holding plateaus.

10. The breast pump of claim **7**, wherein the flange comprises:

a pliable breast interface-body portion configured to form an air tight seal between the flange and a human breast;

a flange top positioned away from the breast when the breast is in operable contact with the flange;

at least one sidewall extending from the flange top and faired into the breast interface body portion, the flange top and sidewall defining a vacuum chamber in communication with the breast;

an outlet through the vacuum chamber;

a one-way valve coupled to the outlet and operable for allowing milk to pass through the outlet when a compression force is applied to the flange top to create positive pressure within the vacuum chamber, and further operable for sealing the flange to allow the flange to create negative pressure within the vacuum chamber when the compression force is removed from the flange top;

wherein the vacuum chamber comprises a bellows structure to facilitate a reduction of the interior volume of the vacuum chamber when the compression force is applied to the flange top; and

the bellows structure further configured to facilitate an expansion of the interior volume of the vacuum chamber to create a negative pressure causing a milking action for expressing milk from the breast.

11. A breast pump comprising:

a housing carrying a self-contained pump mechanism;

a breast interface flange supported by the housing;

an outlet for expelling breast milk received from a breast interfaced with the flange;

the housing and flange being sized and configured to be supported between an adult human breast and a breast cup of a bra while the breast pump is actively pumping milk from the breast and expelling the milk through the outlet; and

a one-way valve operative for allowing milk to pass through the outlet when the flange is compressed by the pump mechanism to create positive pressure within the flange and sealing the flange to allow a reversal of the compression of the flange to create negative pressure within the flange to create a milking action for causing milk to be expressed by the breast.

12. The breast pump of claim **11**, further comprising a breast milk collection container for collecting milk expelled from the outlet.

13. The breast pump of claim **12**, wherein the breast milk collection container comprises a collection bag comprising an elongated neck configured to be captured and between a lower edge of the bra and the wearer's body to support the collection bag, without the aid of hands or other body-worn supporting devices other than the bra, while the breast pump is actively pumping milk from the breast and expelling the milk through the outlet and into the collection bag.

14. The breast pump of claim **13**, wherein the housing, flange and collection bag are sized and configured to be worn under typical upper body clothing having a normal wearing mode, while the breast pump is actively pumping

milk from the breast and expelling the milk through the outlet, with the upper body clothing worn in its normal wearing mode.

15. A breast pump, comprising:

a mechanical actuator;

a breast interface flange configured to form a vacuum chamber between the flange and a human breast comprising a flange top positioned away from the breast when the breast is in operable contact with the flange;

an outlet through the vacuum chamber;

a one-way valve coupled to the outlet operable for allowing milk to pass through the outlet when a compression force is applied to the flange top to create positive pressure within the vacuum chamber, and further operable for sealing the flange to allow the flange to create negative pressure within the vacuum chamber when the compression force is removed from the flange top;

wherein the vacuum chamber comprises a bellows structure to facilitate a reduction of the interior volume of the vacuum chamber when the compression force is applied to the flange top; and

the bellows structure further configured to facilitate an expansion of the interior volume of the vacuum chamber to create a negative pressure causing a milking action for expressing milk from the breast.

16. The breast pump of claim **15**, further comprising a breast milk collection container for collecting milk expelled from the outlet configured to be attached to the breast pump while the is pump is actively pumping milk expressed from the breast into the container.

17. The breast pump of claim **16**, wherein the breast milk collection container comprises a collection bag comprising an elongated neck configured to be captured and between a lower edge of the bra and the wearer's body to support the collection bag without the aid of hands or other body-worn supporting devices other than the bra, while the breast pump is actively pumping milk from the breast and expelling the milk through the outlet and into the collection bag.

18. The breast pump of claim **17**, wherein the mechanical actuator and the breast interface flange are supported by a housing that is sized and configured to be supported between an adult human breast and a breast cup of a bra, without the aid of hands or other body-worn supporting devices other than the bra, while the breast pump is actively pumping milk from the breast and expelling the milk through the outlet.

19. The breast pump of claim **18**, wherein the housing, flange and collection bag are sized and configured to be worn under typical upper body clothing having a normal wearing mode, while the breast pump is actively pumping milk from the breast and expelling the milk through the outlet, with the upper body clothing worn in its normal wearing mode.

20. The breast pump of claim **19**, further comprising a receptacle within the housing for receiving a battery or an AC adapter power plug.

21. The breast pump of claim **19**, further comprising a battery receptacle within the housing for receiving a battery for powering the pump mechanism.

22. The breast pump of claim **21**, further comprising an AC power adapter having a power plug configured to be received within the battery receptacle for the powering the pump mechanism contained.

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Lundy

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(45) **Date of Patent: Apr. 30, 2002**

(54) **HANDS-FREE PORTABLE BREAST PUMP SYSTEM**

(76) Inventor: **Ellen F. Lundy**, 406 Seneca Ct., Woodstock, GA (US) 30188

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/843,113**

(22) Filed: **Apr. 25, 2001**

Related U.S. Application Data

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(51) **Int. Cl.**[7] **A61M 1/06**
(52) **U.S. Cl.** **604/74**
(58) **Field of Search** 450/36–38; 2/67; 604/74–76, 343–346, 317; 119/14.12

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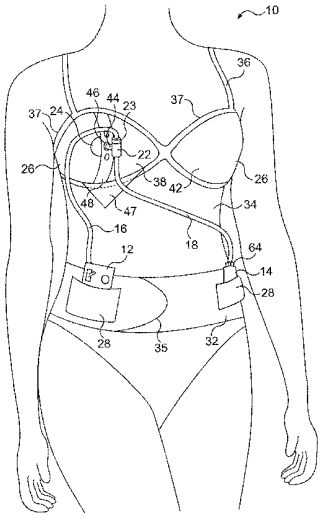
Primary Examiner—Mark Bockelman
(74) *Attorney, Agent, or Firm*—Reed Smith Hazel & Thomas LLP

(57) **ABSTRACT**

A portable breast pump system that includes a breast receptor for receiving a breast, a vacuum suction compartment connected to the breast receptor and a collection container for receiving breast milk. The breast pump system also includes a breast milk collection tube having one end connected to the vacuum suction compartment and the other end connected to the collection container. The system also includes a suction pump connected to the breast receptor and the vacuum suction compartment for creating a vacuum for drawing breast milk into the collection container via the breast milk collection tube. Supporting the breast pump system in a portable manner on a mother are a breast receptor support strap for supporting and securing the breast receptor against the breast and a body strap for positioning on the body. The body strap has at least one retainer for portably holding the collection container or the suction pump.

18 Claims, 5 Drawing Sheets



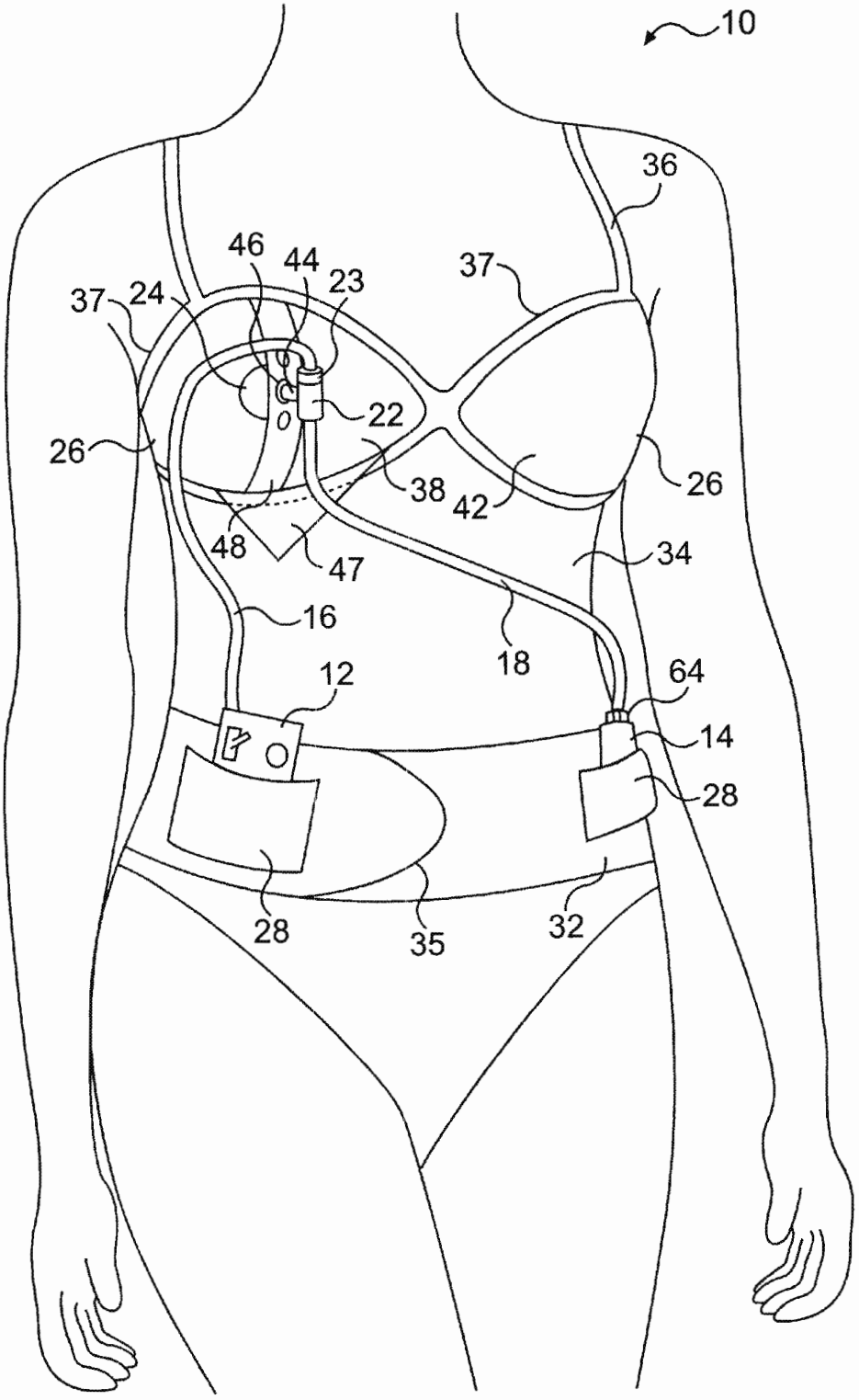

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FIG. 1

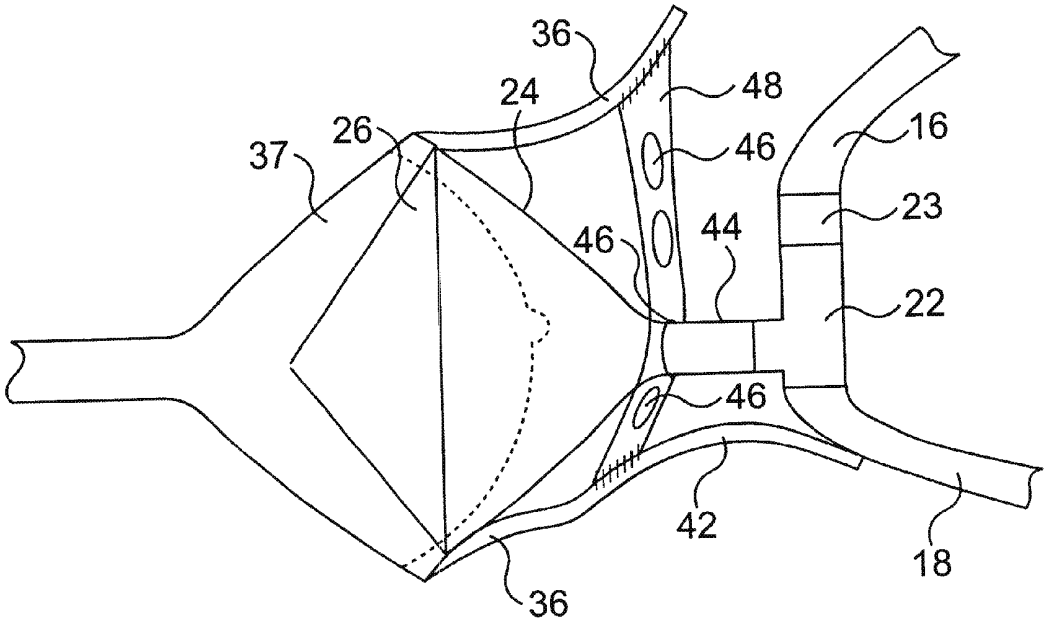

FIG. 2

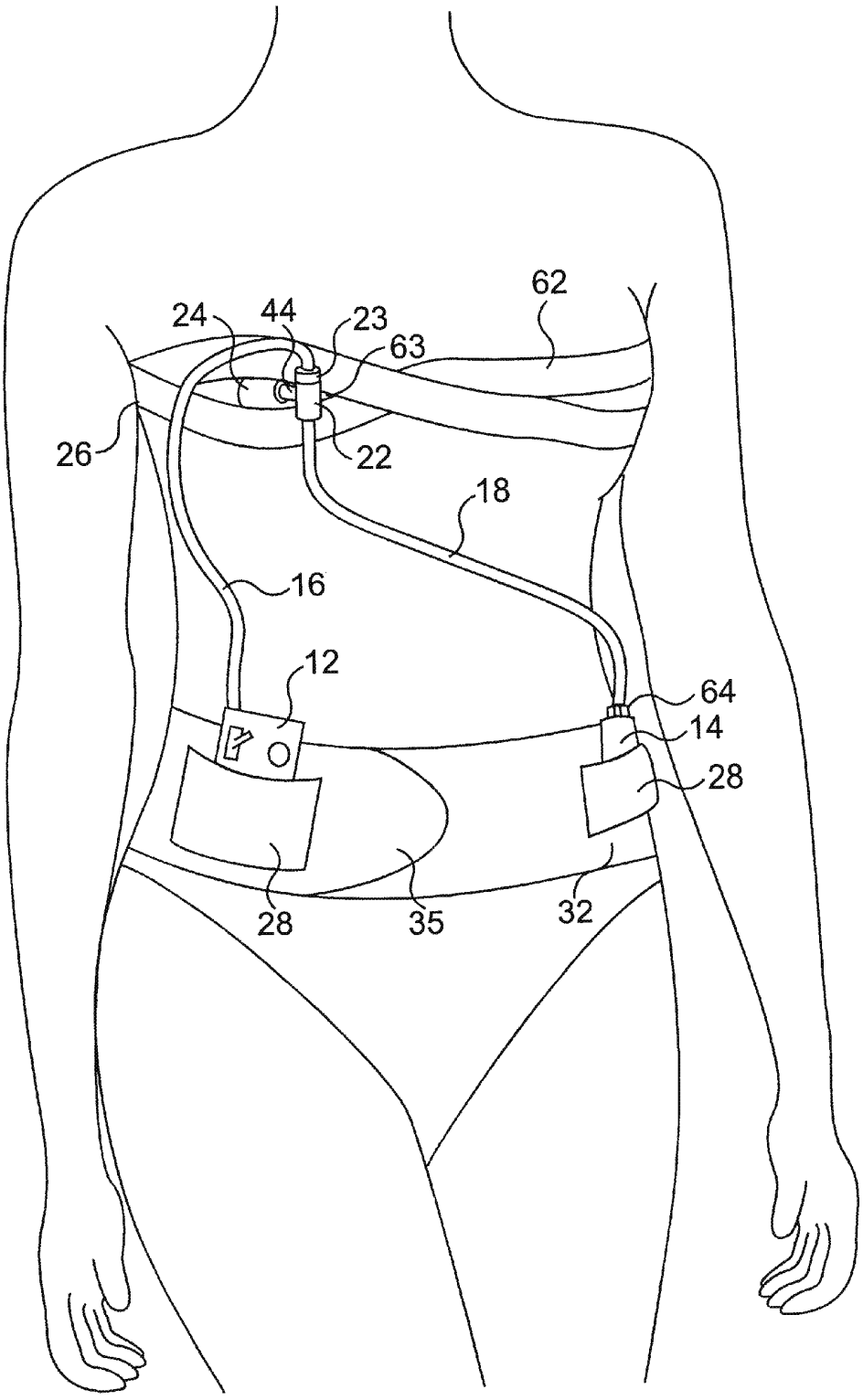

FIG. 3

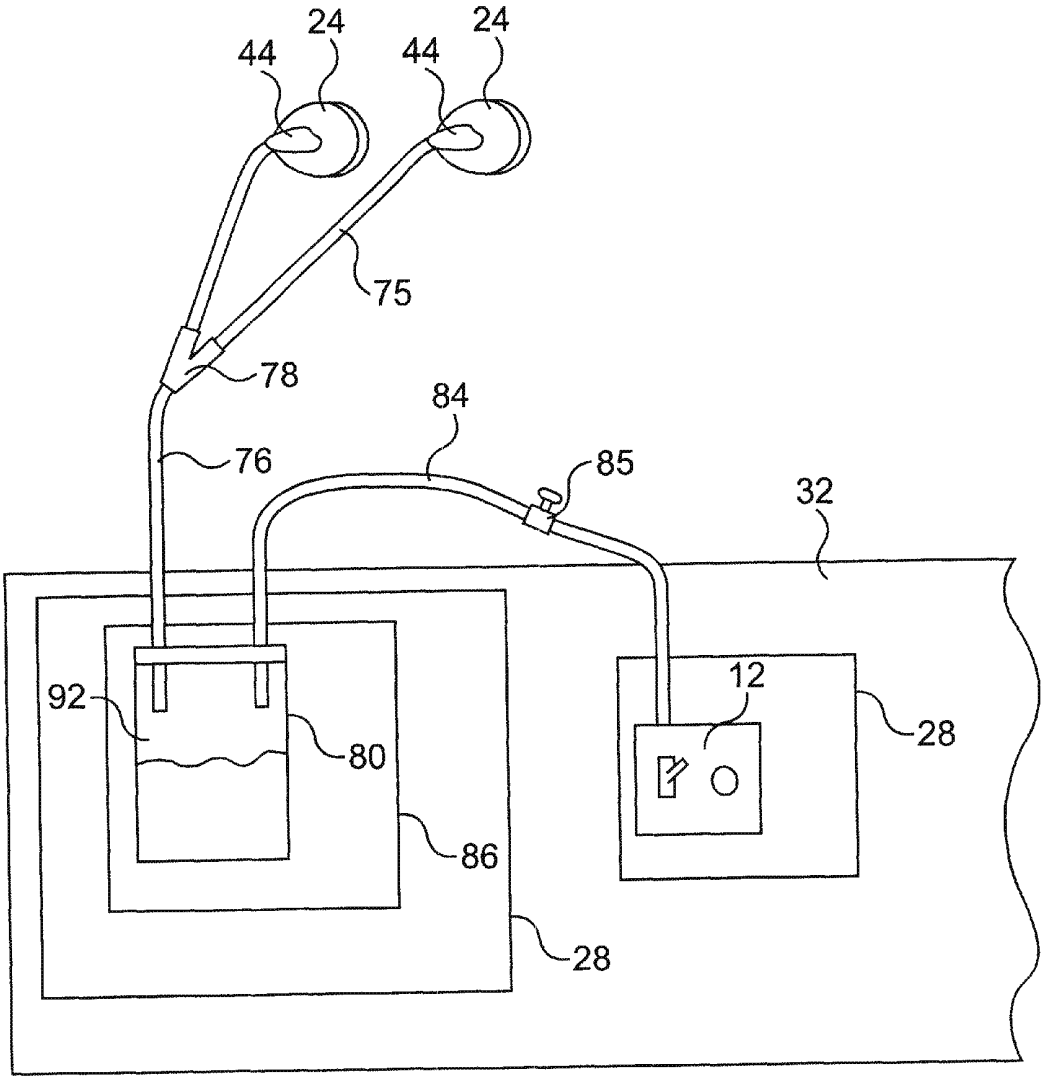

FIG. 4

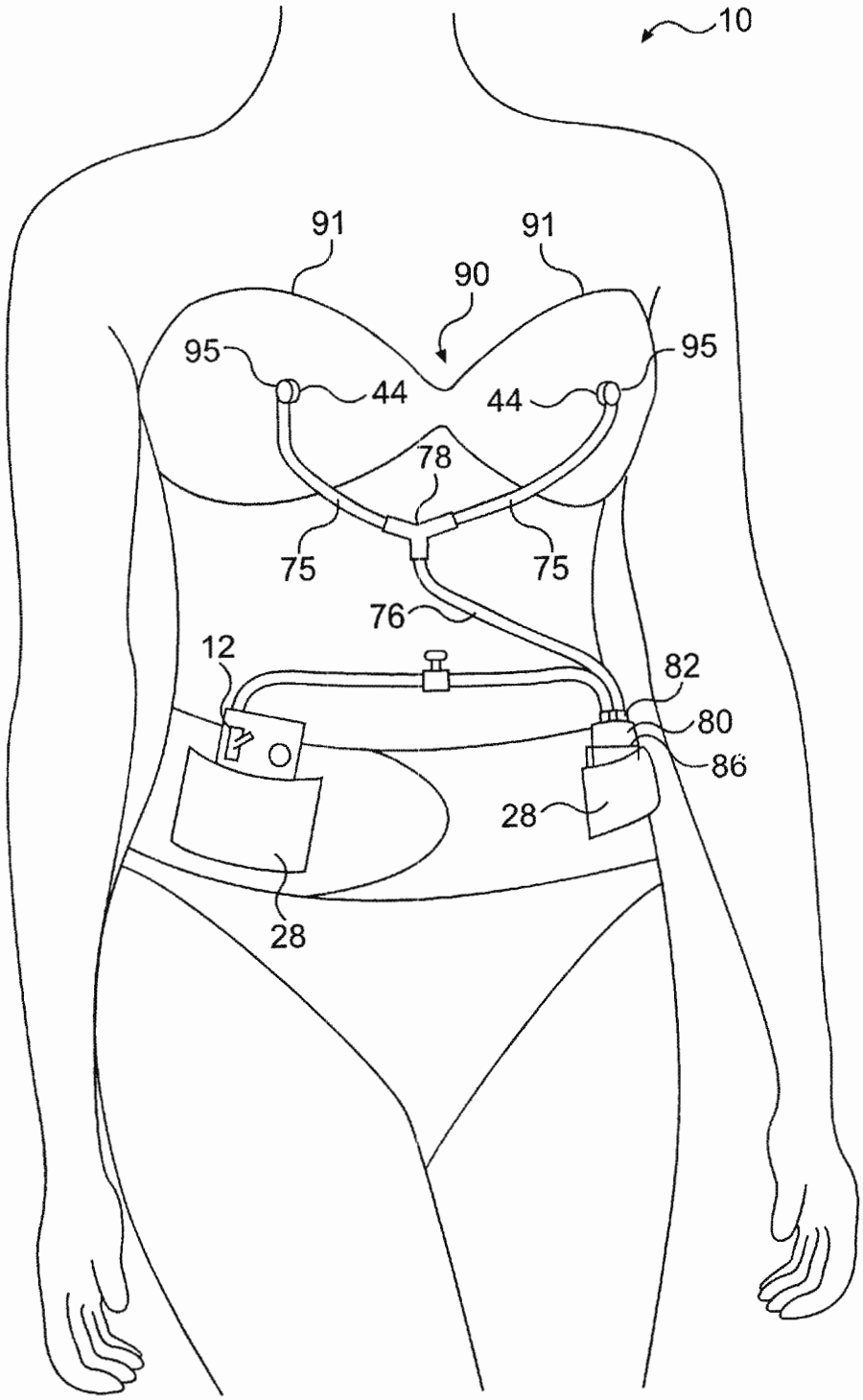

FIG. 5

HANDS-FREE PORTABLE BREAST PUMP SYSTEM

PRIORITY

This divisional application claims benefit of previously filed nonprovisional application Ser. No. 08/540,063 filed on Oct. 6, 1995 pending.

FIELD OF THE INVENTION

The present invention relates to breast pumping systems and, in particular, to portable breast pumping systems.

BACKGROUND OF THE INVENTION

It is believed by many nutritionists that breastfeeding is generally the best source of food and nutrition for an infant. Many experts and mothers believe that numerous immunological and nutritional advantages are provided by breast milk. Because of the benefits of breastfeeding, numerous breast pump devices have been developed which extract milk from a mother's breast for subsequent use when it is inconvenient for the mother to breastfeed the infant.

Although milk obtained by breast pump devices enables an infant to be conveniently fed at a later time, the act of using a breast pump to obtain the milk from the mother may cause the mother to be inconvenienced. Typically, it takes a mother approximately 10–20 minutes to obtain 2–6 ounces of milk to be used for feeding the infant. Because many mothers are "working moms," these mothers typically have many tasks to complete at home, including feeding their infants, in a short period of time. Due to the limited time that a mother has to complete daily obligations, taking time out to breast-feed during busy periods of the day can cause an additional inconvenience to the mother.

While breast pump devices enable a mother to conveniently provide breast milk to the infant without having to actually nurse the infant, breast pump devices require a mother to stop or delay a task at hand to spend time pumping her breast for milk. Prior breast pumps have a vacuum unit, milk container and breast receptacle all constructed as a single unit. With this single unit, the mother must generally sit and hold the breast pump to her breast for the amount of time that is required to extract the milk. Taking time out to sit or otherwise use her hands to hold the breast pump is inconvenient for a busy mother and usually requires the mother to delay accomplishing other tasks.

Thus, there is a need in the art to provide a breast pump system that enables a mother to conveniently collect milk without substantially encumbering or delaying the mother.

SUMMARY OF THE INVENTION

Generally described, the present invention provides a portable hands-free breast pumping system. The breast pumping system collects milk without the mother holding the breast pumping system in place while enabling the mother to perform other tasks unencumbered by the breast pumping system.

More particularly, the present invention provides a portable breast pump system for pumping the breast of a mother that includes a breast pump, a breast milk collection container, a breast receptor connected to the collection container and the breast pump, and a plurality of retaining straps for securing the breast receptor against a breast for collecting milk and for securing the breast milk collection container and the breast pump against the body of the mother. The breast pumping system is secured in a manner

that allows the mother to move freely while milk is extracted from the breast without the mother holding the breast pumping system in position for pumping the breast during collection of milk from the breast.

Described in more detail, the present invention provides a portable breast pump system that includes a breast receptor for receiving a breast, a vacuum suction compartment connected to the breast receptor and a collection container for receiving breast milk. The breast pump system also includes a breast milk collection tube having one end connected to the vacuum suction compartment and the other end of the milk collection tube connected to the collection container. The breast pump system also includes a suction pump connected to the breast receptor and connected to the vacuum suction compartment for creating a vacuum for drawing breast milk into the collection container via the breast milk collection tube. Supporting the breast pump system in a portable manner on a mother are a breast receptor support strap for supporting and securing the breast receptor against the breast and a body strap for positioning on the body upon which the breast is located. The body strap has at least one retainer for portably holding the collection container or the suction pump on the body.

One of the retaining straps may be a breast receptor support bra, having at least one breast support cup. The breast receptor support cup may be adapted to hold the breast receptor in attachment to the breast. The breast support bra may have an opening defined therein for positioning the breast receptor through the opening. The breast receptor has an end for connection with a milk collection tube extending out from the opening in a direction away from the breast. The breast receptor support bra may further include an adjustment strap that has a plurality of position holders attached to the breast support cup. The position holders secure the breast receptor in selected positions in the breast support cup. The adjustment strap is preferably positioned across the opening defined in the breast receptor support bra.

The breast receptor support bra may include two breast support cups and have a second breast receptor for attachment to another breast. A second milk collection tube may be connected to the second breast receptor for drawing breast milk into the container via the second collection tube. Each breast receptor is separately contained in an individual breast support cup.

Additionally, one of the retaining straps may be a body strap for securing on the body upon which the breast is located. The body strap may portably hold the collection container or the suction pump on the body. Preferably, the body strap is a waist belt with pockets. Additionally, the present invention may include a refrigerated container for receiving the collection container and the refrigerated container may also be positioned in the body strap.

Another aspect of the present invention which is generally noted above is the breast receptor support bra. The breast receptor support bra includes a breast support cup. The breast support cup has an opening defined through the breast support cup for receiving a breast receptor of a breast pump. Attached to the breast support cup is an adjustment strap. The adjustment strap has a plurality of position holders attached to the breast support cup and the position holders secure the breast receptor in selected positions in the breast support cup. The breast receptor support bra includes a connection member which is connected to the breast support cup for supporting the breast support cup against the breast when the breast receptor is positioned between a breast and

the breast support cup of the breast pump. The breast receptor support bra may include a second breast support cup. The second breast support cup may have an opening defined through the second breast support cup for receiving a second breast receptor of a breast pump.

Thus, it is an object of the present invention to provide a hands-free breast pumping system.

It is another object of the present invention to provide a breast pumping system which is fully portable and allows a mother to accomplish many tasks unencumbered by the breast pumping system.

It is another object of the present invention to provide retaining straps for supporting the breast pumping system on a mother in a comfortable manner.

It is another object of the present invention to provide a breast receptor support bra with an adjustable support for a breast receptor of the breast pumping system.

These and other objects, features, and advantages of the present invention will become apparent from reading the following description in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows the breast pumping system of the present invention.

FIG. **2** shows a side view of a breast receptor support strap of the present invention and connections with other aspects of the breast pumping system.

FIG. **3** shows another embodiment of breast receptor support strap used with the present invention.

FIG. **4** shows another embodiment of the present invention in which two breast receptors are utilized.

FIG. **5** shows the embodiment of FIG. **4** utilized with another embodiment of breast receptor strap of the present invention.

DETAILED DESCRIPTION

Referring to the Figures, where like numerals reference like parts throughout the several views, the preferred embodiments of the present invention are discussed. Referring to FIG. **1**, a breast pump system **10** includes a breast pump **12**, a collection container **14**, a vacuum tube **16**, a collection tube **18**, a vacuum compartment **22**, a breast receptor **24**, a receptor bra **36**, and a waist belt **32**. The vacuum tube **16** has one end connected to the breast pump **12** and the other end connected to the vacuum compartment **22** in order to provide suction at the breast receptor **24** for extracting breast milk from a breast **26**. The collection tube **18** has one end connected to the vacuum compartment **22** and the other end connected to the collection container **14**. The suction from the breast pump **12** causes breast milk to flow into compartment **22** which then drains down through collection tube **18** into collection bottle **14**. A check valve or filter **23** is provided between vacuum tube **18** and the vacuum compartment **22** to prevent milk from flowing back through the vacuum tube **18** to the breast pump **12**. As illustrated, the collection bottle **14** is located in a pocket **28** of the waist belt **32**. Also, the breast pump **12** is located in a pocket **28** of waist belt **32**. The breast receptor **24** is held in place against the breast **26** by the breast receptor support bra **36**. The breast receptor support bra **36** has openings **38** defined therein that may be covered by a flap **42** of the lower portion of breast support cups **37**. By providing the openings **38**, the breast receptor **24** may be inserted within the receptor support bra **36** for securing the breast receptor **24** in a hands-free manner against the mother's breast **26**. The breast receptor **24** has an extension **44** that extends through an opening **46** defined in an adjustment strap **48** of the receptor support bra **36** in order to connect with the vacuum compartment **22**. The openings **46** in the adjustment strap **48** are spaced apart at selected distances in order that a mother may adjust the breast receptor **24** within the breast receptor support bra **36** to a more comfortable or more functional position.

Because the breast receptor **24**, the breast pump **12** and the collection container **14** are all supported on the person's body or torso **34** by retaining devices or straps such as the waist belt **32** and the breast receptor support bra **36**, the breast pump system **10** of the present invention is a hands-free breast pumping system which allows a mother to engage in other activities while breast milk is being extracted for subsequent use. The breast pump system **10** allows a mother to collect milk unencumbered without having to remain stationary at a pumping station and does not require the mother to manually hold the breast pump **12** or the breast receptors **24** in an appropriate position for collecting milk.

Referring to FIG. **2**, a side view of the breast receptor **24** and the breast receptor support bra **36** is shown. The structure of the breast support cups **37** of the breast receptor support bra **36** has the same general structure as a conventional nursing bra, however, the breast receptor support bra **36** further includes a strap or insert, the adjustment strap **48**, for securing the breast receptor **24** in the breast support cup **37** in an appropriate position against a mother's breast. The adjustment strap **48** may be made of a cloth material or fabric that is sturdy enough to position the breast receptor **24** as desired. It should be appreciated that the adjustment strap **48** may be made of a flexible polymer material or other suitable materials. The material chosen for the adjustment strap **48** should be comfortable against the breast of a mother or should be a combination of materials with the material contacting the breast being suitably comfortable for the mother. The breast receptor **24** may be adjusted up and down by positioning the breast receptor extension **44** in any one of the openings **46** defined in adjustment strap **48**. The adjustment strap **48** may have one end sewn to the upper portion of the breast support cup **37** and have the other end sewn to the lower portion of breast support cup **37**. The adjustment straps **48** may be attached to the breast support cups **37** in any suitable manner known by those skilled in the art. The breast receptor **24** may be made of hard plastic as generally used in making conventional handheld breast pumps. The breast receptor **24** may also be made of soft silicone or rubber material which is comfortable to a normal adult female breast.

The breast receptor **24** has a large end which tapers down to a small end to form a conical shape. At the smaller end of the breast receptor is an extension **44** through which fluid, such as breast milk, may pass. The smaller end includes an opening through which the fluid may pass to the collection tube **18**. The shape of the large end should be designed to comfortably fit or accommodate breasts of various sizes. The plastic or material forming the breast receptor **24** is preferably transparent to insure proper application to the nipple and areola which helps a mother avoid sore nipples caused by improper application of the receptor **24**. Connected to the breast receptor **24** via the vacuum compartment **22** are the vacuum tube **18** and the collection tube **16**. The vacuum tube **18** and the collection tube **16** are preferably cylindrical in shape and are made of a flexible material that has a thickness substantial enough to prevent the tube from collapsing under

a reduction of internal air pressure when the vacuum is created by activation of the breast pump **12**. Each of the tubes should snugly fit on the connecting devices in an airtight manner or a liquid-tight manner to prevent leakage during the pumping process. Each of the tubes **16** and **18** should be long enough and have enough flexibility to comfortably extend from the vacuum compartment **22** to waist belt **32** containing the breast pump **12** and collection container **14**.

Referring to FIG. **3**, another embodiment of a receptor support strap is shown utilized with the present invention. The breast receptor **24** may be held in place by an adjustable receptor strap **62** which wraps around the upper torso of the mother. The adjustable receptor strap **62** has an opening **63** for receiving and supporting the breast receptor **24**. The opening **63** may be sized to receive the extension **44** of the breast receptor **24** or the opening may be large enough to receive the conical portion of the breast receptor **24**. When the opening is large enough to receive the conical portion of the breast receptor **24**, the opening of adjustable strap **62** should be made of elastic-type material in order to support breast receptors of various sizes. The adjustable strap **62** may be made of flexible/breathable soft material, such as stretch nylon, with VELCRO® attachments or other suitable fasteners as known by those skilled in the art.

Referring to FIGS. **1** and **3**, the waist belt **32** should be made of comfortable material such as nylon. As noted above, the waist belt **32** may fasten around the waist with VELCRO® attachments or any suitable fasteners. The waist belt **32** may be made of a woven textile material or any other suitable material. The pockets **28** of the waist belt **32** may be made of the same or material different from the material of the waist belt. It should be appreciated that pockets **28** are not the only means for securing or retaining the breast pump **12** or the collection bottle **14** to the waist belt **32**. For example, the waist belt **32** may include retainers that hook into a slot on a breast pump **12** or collection bottle **14**, the retainers may include a belt that slides through a loop on the breast pump **12** or collection bottle **14** or the retainers may be elastic bands which are strong enough to support either the breast pump **12** or the collection bottle **14** when placed between the elastic band and the waist belt **32**.

The breast pump **12** may be a low vacuum suction pump operated by batteries or may be used with an AC adapter. A breast pump that **12** that may be used with the present invention is a small pump may be comfortably supported by or carried in the waist belt **32** which may be a back support belt such as available from orthopedic supply firms, for example, Best Orthopedic Products, Inc. of Hickory, N.C. The breast pump may comprise a normal vibration pressure/vacuum, an adjustable suction regulator, an adjustable cycle valve and a battery pack. Vacuum pressure should be adjustable and operate within a range from zero to 280 mm Hg. Adjustments to the vacuum suction of the pump can be made by adjusting the appropriate control on the vacuum or the vacuum line as known by those skilled in the art. The breast pump **12** may be operated on an intermittent basis simulating the suction of a newborn infant. The suction cycle may also be varied by adjustment of a control on the breast pump **12**. The suction cycle is preferably from 0.5 seconds to 120 seconds. The breast pump **12** may also include a timer that cycles on and off at selected intervals. For example, the timer may cycle on or off every two to three hours.

The process of extracting milk from a mother's breast is as follows. When the suction pump **12** is turned on, a vacuum is created in the vacuum tube and up to the vacuum compartment **22**. The vacuum created at the vacuum compartment **22** causes a vacuum or suction action through the breast receptor cup **24** when breast receptor cup **24** is in connection with breast **26**. Upon the beginning of the suction at the breast **26**, breast milk begins to flow through the vacuum compartment **22** and down through the collection tube **18** to the collection container **14**. As discussed below, the collection container **14** may be enclosed in some form of refrigeration pack or ice pack to keep the breast milk refrigerated. When a mother has determined that enough breast milk has been collected, the mother may turn off the breast pump **12** and remove the collection tube **18** from the collection container **14** for storing the collection container **14** for later use.

Referring to FIGS. **4** and **5**, an alternate embodiment of the present invention shown. FIG. **4** shows two breast receptors **24** simultaneously coupled to the breast pumping system of the present invention. The breast receptors **24** may be positioned in the breast support cups **91** of a receptor support bra **90** as shown in FIG. **5**. Each breast receptor **24** has one end of a collection tube **75** extending from the extensions **44** of the breast receptors **24**. The other end of the collection tubes are connected to a "Y" connector **78** for channeling the milk from each breast down through collection tube **76** and into a collection container **80**. The collection container **80** has a lid **82** through which the collection tube **76** is inserted. The collection container **80** may be housed in a refrigerated container **86** which includes ice or similar refrigerating media in order to refrigerate the milk during and after the collection process. Also, extending through the lid **82** of the collection container **80** is the vacuum tube **84** which is connected to the vacuum pump **12**. By using the embodiment of FIG. **4**, breast milk may be obtained from each breast simultaneously. By using the embodiment shown in FIGS. **4** and **5**, more breast milk may be obtained in a shorter period of time. In the embodiment of FIG. **4**, a vacuum is created in the area **92** within the collection container **80** when the vacuum pump is turned on. The vacuum created within the area **92** of the collection container **80** causes suction to be developed through the collection tubes **75**, at the breast receptors **24** in order to extract milk from a mother's breast.

The breast receptor support bra **90** differs from the breast receptor support bra **36** in that single opening **95** is defined in each breast support cup **91** of the breast receptor support bra **90**. The extension **44** of the breast receptors **24** are positioned through the openings **95** defined in the breast support cups **91**. The breast receptor support bra **90** may have conventional fasteners, as discussed above, to hold the breast receptor support bra **90** in place.

By utilizing the breast receptor support straps of the present invention, a mother may accomplish many tasks with her hands which would not be otherwise possible if the mother had to hold the breast receptors and/or pump to her breast. Additionally, when the waist belt **32** of the present invention is utilized in conjunction with the breast receptor support bra of the present invention, an entirely portable and hands-free breast pumping system is provided.

The present invention is particularly useful to a mother who is unable to nurse her child due to reasons such as recovery from a "Cesarean" section, the child being born prematurely, illnesses which necessitate a need for intensive care and intravenous feedings, or when the mother is working and the infant is in daycare. Using the breast receptor support bra **36** to securely hold the breast receptors in place during the pumping process allows a mother to use the system overnight. By using this system overnight, the mother will be able to attach the breast pump system of the

present invention before sleeping which allow the pump to work during the night. The pump may slowly extract or pump every ten to 120 seconds and may collect milk in a refrigerated unit or refrigerated ice chest as is shown in FIG. **4**. During the day, the present invention allows the mother to collect breast milk virtually unencumbered by the breast pump system of the present invention.

The foregoing relates to the preferred embodiment of the present invention, and many changes may be made therein without departing from the scope of the invention as defined by the following claims.

What is claimed is:

1. A portable breast pump system, comprising:

a breast receptor for receiving a breast;

a vacuum suction compartment connected to said breast receptor;

a collection container for receiving breast milk;

a breast milk collection tube having one end connected to said vacuum suction compartment and the other end of said breast milk collection tube connected to said collection container;

a suction pump connected to said breast receptor and connected to said vacuum suction compartment for creating a vacuum for drawing breast milk into said collection container via said breast milk collection tube;

a breast receptor support strap for supporting and securing said breast receptor against said breast; and

a body strap for positioning on the body upon which said breast is located, said body strap having at least one retainer, said retainer for portably holding said collection container and said suction pump on said body.

2. The apparatus of claim **1** wherein said breast receptor support strap comprises a breast receptor support bra, having at least one breast support cup, adapted to hold said breast receptor in attachment to said breast.

3. The apparatus of claim **2** wherein said breast support bra has an opening defined therein for positioning said breast receptor through said opening, said breast receptor having an end for connection with said breast milk collection tube extending out from said opening in a direction away from said breast.

4. The apparatus of claim **3** wherein said breast receptor support bra further comprises an adjustment strap having a plurality of position holders attached to said breast support cup, said position holders for securing said breast receptor in selected positions in said breast support cup.

5. The apparatus of claim **4** wherein said adjustment strap is positioned across said opening defined in said breast receptor support bra.

6. The apparatus of claim **2** wherein said breast receptor support bra comprises two breast support cups and said system further comprising a second breast receptor for attachment to another breast and a second tube connected to said second breast receptor for drawing breast milk into said container via said second tube, each of said breast receptors being contained in a separate one of said two breast support cups.

7. The apparatus of claim **1** further comprising a refrigerated container for receiving said collection container and said refrigerated container for positioning in a retainer of said body strap.

8. The apparatus of claim **1** wherein said body strap comprises a waist belt for positioning on the waist of said body.

9. The apparatus of claim **8** wherein said retainer comprises a pocket.

10. A portable breast pump system for pumping the breast of a mother, comprising:

a breast pump assembly including a breast receptor and a pumping device;

a breast milk collection container;

said breast receptor connected to said collection container and said pumping device; and

a plurality of retaining straps for securing said breast receptor against a breast for collecting milk from said breast and for securing said breast milk collection container and said pumping device against the body of said mother in a manner that allows said mother to move freely while milk is extracted from said breast without said mother holding said breast pumping system in position for pumping said breast during collection of milk from said breast.

11. The apparatus of claim **10** wherein one of said retaining straps comprises a breast receptor support bra, having at least one breast support cup, adapted to hold said breast receptor in attachment to said breast.

12. The apparatus of claim **11** wherein said breast support bra has an opening defined therein for positioning said breast receptor through said opening, said breast receptor having an end for connection with said collection container extending out from said opening in a direction away from said breast.

13. The apparatus of claim **12** wherein said breast receptor support bra further comprises an adjustment strap having a plurality of position holders attached to said breast support cup, said position holders for securing said breast receptor is selected positions in said breast support cup.

14. The apparatus of claim **13** wherein said adjustment strap is positioned across said opening defined in said breast support bra.

15. The apparatus of claim **11** wherein said breast receptor support bra comprises two breast support cups and said system further comprising a second breast receptor for attachment to another breast and a said second breast receptor connected to said breast milk collection container for drawing breast milk into said container via said second tube, each of said breast receptors being contained in a separate one of said two breast support cups.

16. The apparatus of claim **10** further comprising a refrigerated container for receiving said breast milk collection container and said refrigerated for positioning in a retainer of said body strap.

17. The apparatus of claim **10** wherein one of said retaining straps comprises a body strap for positioning on the body upon which said breast is located, said body strap having at least one retainer, said retainer for portably holding said collection container or said pumping device on said body.

18. The apparatus of claim **17** wherein said body strap comprises a waist belt for positioning on the waist of said body.

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is moving or to a current **2 a** (1) : appearance to the eye or mind (2) : a particular appearance of countenance: MIEN ⟨a man surly in ~⟩ **b** : a particular status or phase in which something appears or may be regarded ⟨studied every ~ of the question⟩ **3** *archaic* : an act of looking : GAZE **4 a** : the nature of the action of a verb as to its beginning, duration, completion, or repetition and without reference to its position in time **b** : a set of inflected verb forms that indicate aspect ***syn*** see PHASE — **as·pec·tu·al** \a-'spek-chə(-wə)l\ *adj*

aspect ratio *n* : a ratio of one dimension to another: as **a** : the ratio or span to mean chord of an airfoil **b** : the ratio of the width of a television or motion-picture image to its height

as·pen \'as-pən\ *n* [alter of ME *asp*, fr. OE *æspe;* akin to OHG *aspa* aspen, Latvian *apsa*] : any of several poplars (esp. *Populus tremula* of Europe and *P. tremuloides* and *P. grandidentata* of No. America) with leaves that flutter in the lightest wind because of their flattened petioles — **aspen** *adj*

as·per·ges \ə-'spər-(,)jēz\ *n* [L, thou wilt sprinkle, fr. *aspergere*] : a ceremony of sprinkling altar, clergy, and people with holy water

as·per·gil·lo·sis \,as-pər-(,)jil-'ō-səs\ *n, pl* **-lo·ses** \-,sēz\ : infection with or disease caused (as in poultry) by molds (genus *Aspergillus*)

as·per·gil·lum \,as-pər-'jil-əm\ *n, pl* **-la** \-ə\ *or* **-lums** [NL, fr. L *aspergere*] : a brush or small perforated container with a handle that is used for sprinkling holy water in a liturgical service

as·per·gil·lus \-'jil-əs\ *n, pl* **-gil·li** \-'jil-,ī\ [NL, genus name, fr. *aspergillum*] : any of a genus (*Aspergillus*) of ascomycetous fungi with branched radiate sporophores including many common molds

as·per·i·ty \a-'sper-ət-ē, ə-\ *n, pl* **-ties** [ME *asprete*, fr. OF *aspreté*, fr. *aspre* rough, fr. L *asper*] **1** : RIGOR, SEVERITY **2 a** : roughness of surface : UNEVENNESS **b** : roughness of sound **3** : roughness of manner or of temper : HARSHNESS ***syn*** see ACRIMONY ***ant*** amenity

as·perse \ə-'spərs, a-\ *vt* **as·persed; as·pers·ing** [L *aspersus*, pp. of *aspergere*, fr. *ad-* + *spargere* to scatter — more at SPARK] **1** : SPRINKLE; *esp* : to sprinkle with holy water **2** : to attack with evil reports or false or injurious charges ***syn*** see MALIGN

as·per·sion \ə-'spər-zhən, -shən\ *n* **1** : a sprinkling with water esp. in religious ceremonies **2 a** : the act of calumniating : DEFAMATION **b** : a calumnious expression ⟨he cast ~s on her integrity⟩ ***syn*** see ANIMADVERSION

as·phalt \'as-,fȯlt\ *or* **as·phal·tum** \as-'fȯl-təm\ *n* [ME *aspalt*, fr. LL *aspaltus*, fr. Gk *asphaltos*] **1** : a brown to black bituminous substance that is found in natural beds and is also obtained as a residue in petroleum refining and that consists chiefly of hydrocarbons **2** : an asphaltic composition used for pavements and as a waterproof cement — **as·phal·tic** \as-'fȯl-tik\ *adj*

as·phalt·ite \'as-,fȯl-,tīt\ *n* : a native asphalt occurring in vein deposits below the surface of the ground

asphalt jungle *n* : a big city or a specified part of a big city

as·pher·ic \(')ā-'sfi(ə)r-ik, -'sfer-\ *or* **aspher·i·cal** \-i-kəl\ *adj* **1** : departing slightly from the spherical form ⟨~ optical surface⟩ **2** : free from spherical aberration ⟨an ~ lens⟩

as·pho·del \'as-fə-,del\ *n* [L *asphodelus*, fr. Gk *asphodelos*] : any of various Old World usu. perennial herbs (esp. genera *Asphodelus* and *Asphodeline*) of the lily family with flowers in long erect racemes

as·phyx·ia \as-'fik-sē-ə, əs-\ *n* [NL, fr. Gk, stopping of the pulse, fr. *a-* + *sphyzein* to throb] : a lack of oxygen or excess of carbon dioxide in the body that is usu. caused by interruption of breathing and that causes unconsciousness

as·phyx·i·ate \-sē-,āt\ *vb* **-at·ed; -at·ing** *vt* : to cause asphyxia in; *also* : to kill or make unconscious through want of adequate oxygen, presence of noxious agents, or other obstruction to normal breathing ~ *vi* : to become asphyxiated — **as·phyx·i·a·tion** \-,fik-sē-'ā-shən\ *n* — **as·phyx·i·a·tor** \-'fik-sē-,āt-ər\ *n*

[1]as·pic \'as-pik\ *n* [MF, alter. of *aspe*, fr. L *aspis*] *obs* : [2]ASP

[2]aspic *n* [F, lit., asp] : a savory jelly (as of fish or meat stock) used cold to garnish meat or fish or to make a mold of meat, fish, or vegetables

as·pi·dis·tra \,as-pə-'dis-trə\ *n* [NL, irreg. fr. Gk *aspid-*, *aspis* shield] : an Asiatic plant (*Aspidistra lurida*) of the lily family that has large basal leaves and is often grown as a foliage plant

[1]as·pi·rant \'as-p(ə-)rənt, ə-'spī-rənt\ *n* : one who aspires ⟨presidential ~s⟩

[2]aspirant *adj* : seeking to attain a desired position or status

[1]as·pi·rate \'as-pə-,rāt\ *vt* **-rat·ed; -rat·ing** [L *aspiratus*, pp. of *aspirare*] **1** : to pronounce (a vowel, a consonant, or a word) with an accompanying *h*-sound **2 a** : to draw by suction **b** : to remove (as blood) by aspiration

[2]as·pi·rate \'as-p(ə-)rət\ *n* **1** : an independent sound \h\ or a character (as the letter *h*) representing it **2** : a consonant having aspiration as its final component ⟨in English the *p* of *pit* represents an ~⟩ **3** : material removed by aspiration

as·pi·ra·tion \,as-pə-'rā-shən\ *n* **1** : the pronunciation or addition of an aspirate; *also* : the aspirate or its symbol **2** : a drawing of something in, out, up, or through by or as if by suction: as **a** : the act of breathing and esp. of breathing in **b** : the withdrawal of fluid from the body **c** : the taking of foreign matter into the lungs with the respiratory current **3 a** : a strong desire to achieve something high or great **b** : an object of such desire ***syn*** see AMBITION

as·pi·ra·tor \'as-pə-,rāt-ər\ *n* : an apparatus for producing suction or moving or collecting materials by suction; *esp* : a hollow tubular instrument connected with a partial vacuum and used to remove fluid or tissue or foreign bodies from the body

as·pire \ə-'spī(ə)r\ *vi* **as·pired; as·pir·ing** [ME *aspiren*, fr. MF or L; MF *aspirer*, fr. L *aspirare*, lit., to breathe upon, fr. *ad-* + *spirare* to breathe — more at SPIRIT] **1** : to seek to attain or accomplish a particular goal ⟨*aspired* to a career in medicine⟩ **2** : ASCEND, SOAR — **as·pir·er** *n*

as·pi·rin \'as-p(ə-)rən\ *n, pl* **aspirin** *or* **aspirins** [ISV, fr. acetyl + *spir*aeic acid (former name of salicylic acid), fr. NL *Spiraea*, genus of shrubs — more at SPIREA] **1** : a white crystalline derivative $C_9H_8O_4$ of salicylic acid used for relief of pain and fever **2** : a tablet of aspirin

ASR *abbr* **1** airport surveillance radar **2** air-sea rescue

as regards *or* **as respects** *prep* : in regard to : with respect to

[1]ass \'as\ *n* [ME, fr. OE *assa*, perh. fr. OIr *asan*, fr. L *asinus*] **1** : any of several hardy gregarious mammals (genus *Equus*) that are smaller than the horse, have long ears, and include the donkey **2** : a stupid, obstinate, or perverse person

asses 1

[2]ass \'as\ *or* **arse** \'ärs\ *n* [ME *ars, ers*, fr. OE *ærs, ears;* akin to OHG & ON *ars* buttocks, Gk *orrhos*, Arm *or*, Hitt *arraš*, OIr *err* tail] **1 a** : BUTTOCKS — often considered vulgar **b** : ANUS — often considered vulgar **2** : SEXUAL INTERCOURSE — usu. considered vulgar

as·sa·fet·i·da *or* **as·sa·foe·ti·da** *var of* ASAFETIDA

as·sai \ä-'sī\ *adv* [It, fr. (assumed) VL *ad satis* enough — more at ASSET] : VERY — used with tempo direction in music ⟨allegro ~⟩

as·sail \ə-'sā(ə)l\ *vt* [ME *assailen*, fr. OF *asaillir*, fr. (assumed) VL *assalire*, alter. of L *assilire* to leap upon, fr. *ad-* + *salire* to leap — more at SALLY] : to attack violently with blows or words ***syn*** see ATTACK — **as·sail·able** \-'sā-lə-bəl\ *adj* — **as·sail·ant** \-'sā-lənt\ *n*

As·sam·ese \,as-ə-'mēz, -'mēs\ *n, pl* **Assamese** **1** : a native or inhabitant of Assam, India **2** : the Indic language of Assam

as·sas·sin \ə-'sas-ᵊn\ *n* [ML *assassinus*, fr. Ar *ḥashshāshin*, pl. of *ḥashshāsh* one who smokes or chews hashish] **1** *cap* : one of a secret order of Muslims that at the time of the Crusades terrorized Christians and other enemies by secret murder committed under the influence of hashish **2** : MURDERER; *esp* : one that murders a politically important person either for hire or from fanatical motives

as·sas·si·nate \ə-'sas-ᵊn-,āt\ *vt* **-nat·ed; -nat·ing** **1** : to murder by sudden or secret attack usu. for impersonal reasons ⟨~ a senator⟩ **2** : to injure or destroy unexpectedly and treacherously ***syn*** see KILL — **as·sas·si·na·tion** \-,sas-ᵊn-'ā-shən\ *n* — **as·sas·si·na·tor** \-'sas-ᵊn-,āt-ər\ *n*

assassin bug *n* : any of a family (Reduviidae) of bugs that are usu. predatory on insects though some suck the blood of mammals : CONENOSE

[1]as·sault \ə-'sȯlt\ *n* [ME *assaut*, fr. OF, fr. (assumed) VL *assaltus*, fr. *assaltus*, pp. of *assalire*] **1** : a violent physical or verbal attack **2 a** : an apparently violent attempt or a willful offer with force or violence to do hurt to another without the actual doing of the hurt threatened (as by lifting the fist in a threatening manner) — compare BATTERY 1b **b** : RAPE

[2]assault *vt* **1** : to make an assault on **2** : RAPE ~ *vi* : to make an assault ***syn*** see ATTACK — **as·sault·er** *n* — **as·sault·ive** \-'sȯl-tiv\ *adj* — **as·sault·ive·ly** *adv* — **as·sault·ive·ness** *n*

assault boat *n* : a small portable boat used in an amphibious military attack or in land warfare for crossing rivers or lakes

[1]as·say \'as-,ā, a-'sā\ *n* [ME, fr. OF *essai, assai* test, effort — more at ESSAY] **1** *archaic* : TRIAL, ATTEMPT **2** : examination and determination as to characteristics (as weight, measure, or quality) **3** : analysis (as of an ore or drug) to determine the presence, absence, or quantity of one or more components **4** : a substance to be assayed; *also* : the tabulated result of assaying

[2]as·say \a-'sā, 'as-,ā\ *vt* **1** : TRY, ATTEMPT **2 a** : to analyze (as an ore) for one or more valuable components **b** : to judge the worth of : ESTIMATE ~ *vi* : to prove up in an assay — **as·say·er** *n*

as·se·gai *or* **as·sa·gai** \'as-i-,gī\ *n* [deriv. of Ar *az-zaghāya* the assegai, fr. *al-* the + *zaghāya* assegai] : a slender hardwood spear or light javelin usu. tipped with iron and used in southern Africa

as·sem·blage \ə-'sem-blij, *for 3 also* ,as-,äm-'bläzh\ *n* **1** : a collection of persons or things : GATHERING **2** : the act of assembling : the state of being assembled **3 a** : an artistic composition made from scraps, junk, and odds and ends (as of paper, cloth, wood, stone, or metal) **b** : the art of making assemblages

as·sem·blag·ist \-blij-əst, -'bläzh-əst\ *n* : an artist who specializes in assemblages

as·sem·ble \ə-'sem-bəl\ *vb* **as·sem·bled; as·sem·bling** \-b(ə-)liŋ\ [ME *assemblen*, fr. OF *assembler*, fr. (assumed) VL *assimulare*, fr. L *ad-* + *simul* together — more at SAME] *vt* **1** : to bring together (as in a particular place or for a particular purpose) **2** : to fit together the parts of ~ *vi* : to meet together : CONVENE ***syn*** see GATHER

as·sem·bler \-b(ə-)lər\ *n* **1** : one that assembles **2** : a computer program that automatically converts instructions written in a symbolic code into the equivalent machine code

as·sem·bly \ə-'sem-blē\ *n, pl* **-blies** [ME *assemblee*, fr. MF, fr. OF, fr. *assembler*] **1** : a company of persons gathered for deliberation and legislation, worship, or entertainment **2** *cap* : a legislative body; *specif* : the lower house of a legislature **3** : ASSEMBLAGE 1, 2 **4** : a signal given by drum, bugle, trumpet, or all field music for troops to assemble or fall in **5 a** : the fitting together of manufactured parts into a complete machine, structure, or unit of a machine **b** : a collection of parts so assembled **6** : the translation of symbolic code to machine code by an assembler

assembly language *n* : a symbolic language for programming a computer that is a close approximation of machine language

assembly line *n* **1** : an arrangement of machines, equipment, and workers in which work passes from operation to operation in direct line until the product is assembled **2** : a process for turning out a finished product in a mechanically efficient manner ⟨academic *assembly lines*⟩

as·sem·bly·man \ə-'sem-blē-mən\ *n* : a member of an assembly

Assembly of God : a congregation belonging to a Pentecostal body founded in the U.S. in 1914

as·sem·bly·wom·an \-,wúm-ən\ *n* : a female member of an assembly